1994

EC95-744 Design and Management of Storage Containment of Fertilizer and Pesticides

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University of Nebraska Cooperative Extension EC95-744-B

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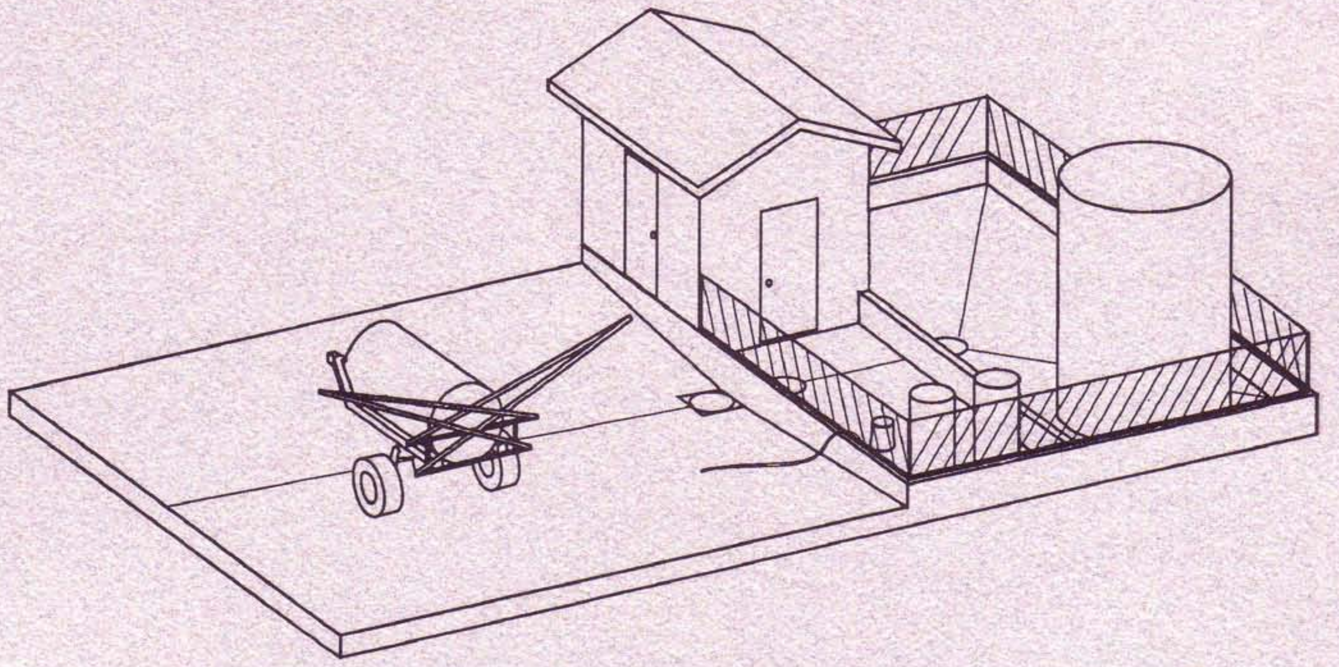

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Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Kenneth R. Bolen, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.

Design and Management of Storage Containment of Fertilizers and Pesticides

This manual is to assist those who need secondary containment for fertilizers and pesticides. This will help develop a construction plan that should meet the State of Nebraska Containment Regulations and assess facility needs, construction materials, size requirements and management needs.

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Storage, handling and disposal of pesticides and fertilizers have been identified by state and federal agencies as practices that create high risks to surface and groundwater quality. The State of Nebraska containment regulations are described in Title 198, "Rules and Regulations Pertaining to Agricultural Chemical Containment." Details of the secondary containment regulations are found in *NebGuide G94-1185, Fertilizer and Pesticide Containment Guidelines*. Following is a summary of minimum storage volumes when secondary containment is required:

Bulk Fertilizer (containers larger than 55 gallons) requires secondary containment for:

- individual containers larger than 2,000 gallons; or
- multiple containers with combined capacity larger than 3,000 gallons; or
- containers larger than 500 gallons that hold quantities exceeding 25 percent of container capacity anytime between Nov. 1 and March 15.

According to a survey by the NDEQ (Buttermore, 1994), the total number of liquid fertilizer storage from 928 farm locations were:

Tank Size (Gals)	Number of Tanks	Average Months of Use	Numbers of Chemigation Tanks
0-500	193	2.2	89
501-1,001	269	1.8	168
1,001-2,000	502	2.3	337
2,001-3,000	44	3.3	7
3,001-5,000	73	3.2	8
5,001-10,000	93	4.1	1
>10,000	70	4.6	0
TOTAL	1,244	___	610

The most common tank size (40 percent) was between 1,001 and 2,000 gallons. Slightly more than 77 percent of all fertilizer storage tanks were 2,000 gallons or smaller.

Bulk Pesticide (containers larger than 55 gallons) requires secondary containment for:

- combined or individual capacity more than 500 gallons.

A practical and economic chemical containment structure with proper management can:

1) improve environmental safety by preventing contamination from accidental spills;
2) improve worker safety;
3) comply with federal and state regulations;
4) enhance owner management and inventory;
5) reduce legal liability; and
6) enhance recovery of spillage.

Standardized designs that meet regulatory requirements will encourage producers to invest in proper containment.

Proper storage management (preventing leaks, spills, etc.) is the first and foremost defense against environmental contamination. If an accident occurs, the secondary containment is intended to be the safety net. Proper design and construction of the secondary containment is essential. Likewise, subsequent, routine inspection and maintenance is imperative if a containment facility is to function as intended.

Management and design factors that should be considered in an agricultural chemical containment facility plan include:

1) the amount of pesticide and fertilizer to be stored;
2) mixing and loading sites;
3) selection of secondary containment materials;
4) worker safety;
5) facility security;
6) storm water and other weather related problems (ie. freezing), and
7) plumbing network.

The following sections provide design and management guidelines and provide information to facilitate the selection of a proper site, design of secondary containment and proper management strategies of these facilities.

Construction Plan

A construction plan is required for each secondary containment facility. Construction plans should include:

1) A scale drawing of plans and specifications, including storage containers, buildings and loadout areas.
2) A copy of the plumbing network of the facility, including location, size and type of plumbing (valve, pumps, etc.) and any back flow prevention devices.
3) The construction plan must be certified by a Nebraska registered engineer or be a generically designed plan approved by NDEQ. The construction plans may be available from several sources. They include the Cooperative Extension and Midwest Plan Service. Generic construction plans are available from the NDEQ. These generic plans are not endorsed by these agencies but provide examples for those who wish to review possible alternatives. The NDEQ does not approve plans but attempts to assure that the facility meets or exceeds the containment regulation requirements.
4) A management program that includes plans for the recycle, reuse, or disposal of accumulations or releases collected in the facility.
5) The construction plan must be kept up-to-date and on file.

Facility Site Selection

Two important factors involved in development of pesticide and/or liquid fertilizer storage facilities are:

1) environmental assessment;

> ENVIRONMENTAL ASSESSMENT: The process of evaluation at a given site/area for possible or potential contamination, or the level, extent and movement of contamination if found. Tools of assessment include visual inspection, water samples, soil samples, examination of public records.

and

2) facility site planning.

The environmental assessment is done to provide legal liability risk protection for the operators, their family, partners and organization. Its value cannot be overemphasized. It is important when selecting a new site to establish a chemical level data base line, especially before purchasing land. If chemical contamination is detected, the legal liabilities in remediation cost of the site are important considerations in the decision to build a facility.

The construction plan should be developed by completing a checklist of environmental assessment guidelines (Appendix, Summary Checklist). The construction plan should include accurate, detailed, engineering drawings (to scale) of the site with the following minimum details showing the location of:

1) existing wells, distance to groundwater and surface water channels (lakes, ponds and streams);
2) neighboring residences or businesses;
3) topographic map showing elevation contour lines and site features;
4) roads, drives and access routes, fences, gates;
5) electrical, gas, and water utility service lines and shut-offs;
6) fire hydrants;
7) fuel storage;
8) livestock housing, feed and water supplies;
9) existing pesticide or fertilizer facilities and mixing areas;
10) prevailing wind directions (by season if varied) should be marked;
11) property lines and easements;
12) sewer lines, septic tanks, and drain fields; and
13) distances from pesticide facilities to water sources (check with your local regulations).

Sizing of Storage Containment

Secondary containment aids recovery of leaks and incidental spills. Secondary containment also can provide control of catastrophic spills that might occur in major accidents. Containment for liquid pesticides and fertilizer consists of a basin with a floor and walls designed to be impervious to liquids. The base should be sloped to a sump where spilled liquid can be pumped and recovered.

Regulations require that the secondary containment capacity be at least equal to that of the largest tank volume plus 10 percent of that tank volume. The containment capacity must also compensate for the volume displaced by other tanks and equipment such as pumps, mixing equipment, concrete anchor blocks and precipitation. If the containment is not roofed, additional volume is needed to hold a 25-year, 24-hour storm, which occurs on the average of once every 25 years. For Nebraska, this rainfall ranges from 3.5 to 6 inches *(Figure 1)*. Note that a 6 inch rain will raise the liquid level more than 6 inches, possibly 9-12 inches, due to floor area displaced by tanks and equipment in the containment area.

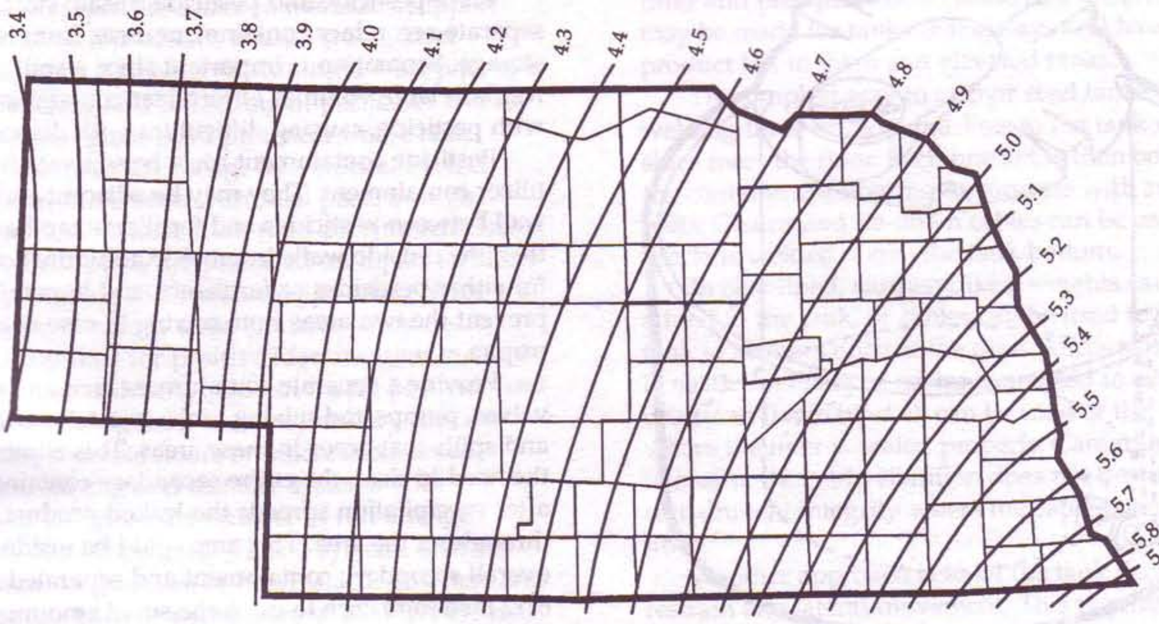

Figure 1. Nebraska rainfall event for a 25-year, 24-hour storm (in inches).

This extra capacity (for rainfall) may be eliminated if a roof diverts precipitation from the containment area. **NOTE:** The fluid remaining in the largest tank at liquid equilibrium may be subtracted from the total to determine containment capacity.

Methods of Secondary Containment

Secondary containment typically consists of a curb, wall or dike constructed around the storage tanks. The wall and floor of a secondary containment must be impervious to liquids for the life of the structure. Secondary containment floors must support gravity loads of full tanks and must resist weather-related cracking and corrosion. The walls must be designed to resist static and hydraulic loads from the equilibrium liquid level. Walls adjacent to large tanks also need to be designed to resist dynamic hydraulic loads from liquids gushing from a ruptured tank.

The following sections describe different methods of secondary containment.

Curbed Areas

Secondary containment of small volumes of pesticide or fertilizer can be accomplished by constructing a small curb around the storage area. This is an excellent method for containing bottles, jugs and small mini-bulk tanks. The curb must completely surround the storage area and must be high enough to have sufficient volume to contain potential spillage plus required freeboard.

One alternative for mini-bulk storage is to provide a concrete curbed pad large enough to hold the entire contents of the largest mini-bulk container. A 6-inch curbed area allows forklift access by a short ramp. *Table I* gives the area required to hold different size mini-bulk tanks and drums in a 6-inch containment depth.

Table I. Secondary containment area for mini-bulk storage. (Assuming a 6 inch curbed area.)

Mini-bulk container size, gal	Containment area per mini-bulk, ft²
60	16
110	30
150	41
200	54
250	67
300	81

Tanks-in-a-Tank

Placing a tank within a tank *(Figure 2)* may be an economical method of providing secondary containment for relatively small, individual tanks. The secondary containment tank must be sufficiently wider than the primary tank to store the volume of fluid in the primary tank above the top of the outer tank plus required freeboard. It also must provide a means of manually pumping precipitation buildup from the secondary tank. The primary tank does not need to be anchored because fluid would remain in it during a spill.

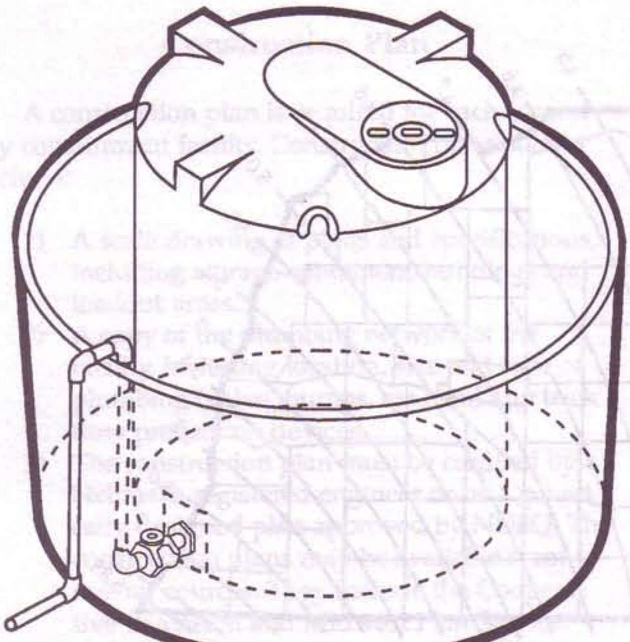

Figure 2. Tank-in-a-Tank example for providing secondary containment.

Large tanks can be contained in a yet larger tank to conserve space. The height of a tank in a tank typically is one-half the tank height. With this, 110 percent of the tank volume can be provided by an outer tank with a diameter of 1.5 times that of the tanks that need containment. An outer tank diameter of 1.6 times the tank diameter provides 125 percent of the tank volume. The tank and outer lining tank require nearly twice as much material for construction as does the tank alone. The outer tank ring should have reinforcement braces anchored to the inner tank.

Functional Containment Design Considerations

According to a 1993 survey by the Biological Systems Engineering Dept. (Reed et al., 1994), only 9 percent of the 91 farm respondents had containment barriers surrounding their pesticide and/or fertilizer storage tanks. But 29 percent of the farmers stated that they could contain and recover a major portion of the losses from a ruptured storage tank.

Pesticides should be kept under a roof. Packaged pesticides should be kept in a separate warehouse and not inside a containment for either bulk pesticides or fertilizers. Flammable pesticides should be kept separate and the warehouse should be curbed to contain water that might be required to extinguish a fire.

Place pesticide and pesticide rinsate storage in separate secondary containment areas from fertilizer storage. Separation is important since a spill could result in large volumes of fertilizer contaminated with pesticide, causing difficulties with disposal.

Pesticide containment must be separate from fertilizer containment. They may be adjacent and the wall between pesticides and fertilizers can be lower than the outside walls to provide additional capacity for either pesticides or fertilizers, and hopefully prevent the two areas from mixing in case of a catastrophe.

Provide a separate containment area around valves, pumps and mixing tanks to catch small leaks and spills that occur in these areas. This eliminates the need to clean the entire secondary containment after precipitation spreads the leaked product throughout the area. This area could be inside the overall secondary containment and separated by a 6-12 inch high curb to catch the small amount of leakage plus any precipitation. Buckets or pans placed under valves, pumps and other working areas also can serve this purpose, but their placement must be routine and they must be anchored against wind or flotation movement. A separate concrete or portable, impervious containment for catching routine leaks from transfer pumps and mixing equipment is especially important for earthen containments around fertilizer storage.

Slope secondary containment floors to a single sump or low point at a 2 percent slope so precipitation can be easily pumped out. It is prohibited to use automatic sump pumps to discharge outside of secondary containment areas. Liquids in a secondary containment must be checked for contamination before discharging them.

Do not allow adjacent roofs to drain into the secondary containment area. Remove precipitation from the secondary containment immediately after it has been determined that it is not contaminated. **NOTE:** Never let precipitation accumulate. If precipitation is contaminated, dispose of it according to the nature of product(s) involved.

Storage Tank Plumbing

Use flexible hoses at the pipe-to-tank connection to prevent potential plumbing rupture if one tank floats or shifts. If rigid steel plumbing between storage tanks is used and a rupture of multiple tanks occurs, the secondary containment could overflow. Use dry couplers to make plumbing connections to avoid small leaks during connection and handling.

Run pipes over containment walls rather than through them. It is difficult to seal around pipes that go through walls and very difficult to ensure the integrity of a seal throughout a facility's life. Also, holes in concrete lead to cracks.

Elevated pipes are easier to maintain; support them with concrete blocks, treated wood, steel frames or other attachments. Run rigid steel pipe to a deck for loading and unloading of pesticides and fertilizers. Do not place rigid pipe near traffic lanes where it is subject to damage by vehicles. Protect rigid pipe from vehicles with steel posts or high curbs. Use flexible hose from rigid pipe to vehicles.

Individual pipes are preferred on liquid fertilizer transfer plumbing to eliminate drips when hoses are switched from tank to tank. Transfer hoses clearly should be marked for positive identification to eliminate cross-contamination. Do not install pesticide and fertilizer plumbing lines under secondary containment slabs, concrete floors or inaccessible areas.

Closed mixing and transfer systems with vacuum or low pressure transfer of full-strength pesticides should be used. Closed systems that can handle liquids, granules or emulsifiable powders and water soluble bags or packets are available. Personal protection requirements on container labels generally are reduced for workers who operate closed mixing and/or transfer systems compared to open mixing facilities.

Tank Anchoring

Attach tanks to solid anchors to prevent flotation when fluids are in the secondary containment. A floating tank can overturn or collide with other tanks, damage associated plumbing and cause additional spills. Empty tanks must be anchored against wind or rising water from rainfall.

Tank anchors and connections must be adequate to resist the tremendous flotation forces encountered when a tank is forced upward by liquid in the secondary containment. Upward forces due to flotation are equal to the weight of the fluid displaced by the empty portion of the tank that is below the fluid level minus the empty tank weight. Flotation force can be calculated by:

$$FLF = (FD \times VD) - TW \qquad \text{[Equation 1]}$$

Where:

FLF = Flotation force, lb,
FD = Fluid density of fertilizer, typically 70-85 lb/ft^3,
VD = Volume of fluid displaced by the tank, ft^3 (*Tables II-IV* give displacement volumes per ft of height of various tanks. *Figure* 3 gives equations for tank volumes),
TW = Empty tank weight, lb.

When calculating flotation force, assume the worst conditions. Assume one tank is empty when another tank leaks and assume that the secondary containment will be filled completely by the leaked fluid and precipitation. In some cases, allowances may be made for tanks that always will have some product left in them and elevated tanks.

The simplest way to anchor steel tanks is by welding three or more brackets to the tank where the sides meet the floor. Each bracket is then bolted to the containment flooring or concrete with anchoring bolts. Chains and tie-down cables can be used with brackets welded above the tank bottom.

In clay-lined, earthen dikes, weights can be added to the tank, or cables can be used to secure the tank to anchors outside the dike. Anchors in the soil beneath the liners or cables connected to concrete deadman (large blocks), can be used at the area where the liner is sealed properly. Care must be taken to ensure the cable vibration does not destroy the containment integrity where the cable penetrates the liner.

Another approach is to let the tank float, but restrain any lateral movement. This requires flexible

Table II. Volume of vertical cylindrical tanks.

Diameter ft	Volume, ft^3 Per foot of height	Volume, ft^3 Per inch of height	Volume, gal Per foot of height	Volume, gal Per inch of height
4	12.57	1.05	94.00	7.83
5	19.63	1.64	146.87	12.24
6	28.27	2.36	211.49	17.62
7	38.48	3.21	287.86	23.99
8	50.27	4.19	375.99	31.33
9	63.62	5.30	475.86	39.65
10	78.54	6.54	587.48	48.96
11	95.03	7.92	710.85	59.24
12	113.10	9.42	845.97	70.50
13	132.73	11.06	992.84	82.74
14	153.94	12.83	1,151.46	95.95
15	176.71	14.73	1,321.83	110.15
16	201.06	16.76	1,503.94	125.33
17	226.98	18.92	1,697.81	141.48
18	254.47	21.21	1,903.43	158.62
19	283.53	23.63	2,120.79	176.73
20	314.16	26.18	2,349.91	195.83

Table III. Volume of horizontal cylindrical tanks*.

Diameter, ft	Volume, ft^3/ft of tank length Per foot of height	Volume, ft^3/ft of tank length Per inch of height	Volume, gal/ft of tank length Per foot of height	Volume, gal/ft of tank length Per inch of height
4	3.37	0.28	25.28	2.11
6	5.06	0.42	37.95	3.16
8	6.74	0.56	50.55	4.21
10	8.43	0.71	63.23	5.27
12	10.11	0.85	75.83	6.32
14	11.80	0.99	88.50	7.38
16	13.50	1.13	101.25	8.44

*These are conservative estimates. After containment wall height is calculated, you can use *Table IV* for accurate volume.

Table IV. Volume of horizontal cylindrical tanks.

Fluid level, ft	Diameter, ft: 4	6	8	10	12	14	16
	------------ Volume, ft^3/ft of length ------------						
0.5	0.91	1.13	1.31	1.47	1.61	1.74	1.87
1.0	2.46	3.10	3.63	4.09	4.50	4.88	5.23
1.5	4.30	5.53	6.52	7.39	8.16	8.86	9.52
2.0	6.28	8.25	9.83	11.18	12.39	13.49	14.51
2.5	8.26	11.15	13.42	15.35	17.07	18.63	20.06
3.0	10.11	14.14	17.22	19.82	22.11	24.19	26.10
3.5	11.66	17.12	21.14	24.50	27.44	30.10	32.53
4.0	12.57	20.02	25.13	29.34	33.00	36.29	39.31
4.5		22.75	29.12	34.28	38.74	42.73	46.37
5.0		25.18	33.05	39.27	44.60	49.35	53.68
5.5		27.15	36.85	44.26	50.56	56.13	61.29
6.0		28.27	40.44	49.20	56.55	63.02	68.87
6.5			43.74	54.04	62.54	69.9	76.67
7.0			46.64	58.72	68.49	76.97	84.57
7.5			48.96	63.19	74.36	83.96	92.54
8.0			50.27	67.36	80.10	90.92	100.53
8.5				71.15	85.66	97.81	108.53
9.0				74.45	90.99	104.58	116.49
9.5				77.07	96.03	111.21	124.39
10.0				78.54	100.71	117.65	132.19
10.5					104.94	123.84	139.87
11.0					108.60	129.75	147.38
11.5					111.48	135.31	154.69
12.0					113.10	140.45	161.75
12.5						145.07	168.53
13.0						149.06	174.96
13.5						152.19	181.00
14.0						153.94	186.56
14.5							191.54
15.0							195.83
15.5							199.19
16.0							201.06

plumbing. It is a good practice to leave fittings and manholes open whenever tanks are empty. In the event of a spill or heavy rainfall, liquid levels inside and outside the tank can equalize and the tank will settle to the containment floor.

Electrical Systems

Elevate electrical items (motors, wiring, controls, etc.) off the containment floor so they do not become submerged during precipitation. Ideally, place electrical components above the top of the secondary containment wall so they are not submerged during a spill. Use Ground-Fault Circuit-Interrupters (GFCI) on all electric circuits within secondary containment and in other areas of pesticide and fertilizer handling facilities (per National Fire Protection Association-NFPA, National Electric Code-NEC).

3a. Horizontal cylindrical or spherical tank volume (V, ft^3).

Horizontal cylindrical tank fluid volume:

$$V = [(D^2 / 4) \times (\cos^{-1} \{ ((D - 2 \times h) / D)\} \div 57.3) - ((D / 2) - h) \times \{(D \times h) - h^2\}^{1/2}] \times L$$

Horizontal cylindrical tank volume equation is for fluid levels below half full. For fluid levels above half full, calculate the air volume and subtract from the total tank volume.

Spherical tank volume:

$$V = 1.0472 \times h^2 \times (1.5 \times (D - h))$$

3b. Vertical cylindrical tank volume (V, ft^3).

$$V = 0.7854 \times D^2 \times h$$

3c. Cone bottom vertical tank volume (V, ft^3).

Fluid level above cone:

$$V = 1.0472 \times h \times (D^2 + d^2 + (D \times d)) + 0.7854 \times D^2 \times (h - c)$$

Fluid level within cone:

$$V = 1.0472 \times h \times (K^2 + d^2 + (K \times d))$$

Where: $K = (h / c) \times D + d \times (1 - (h / c))$

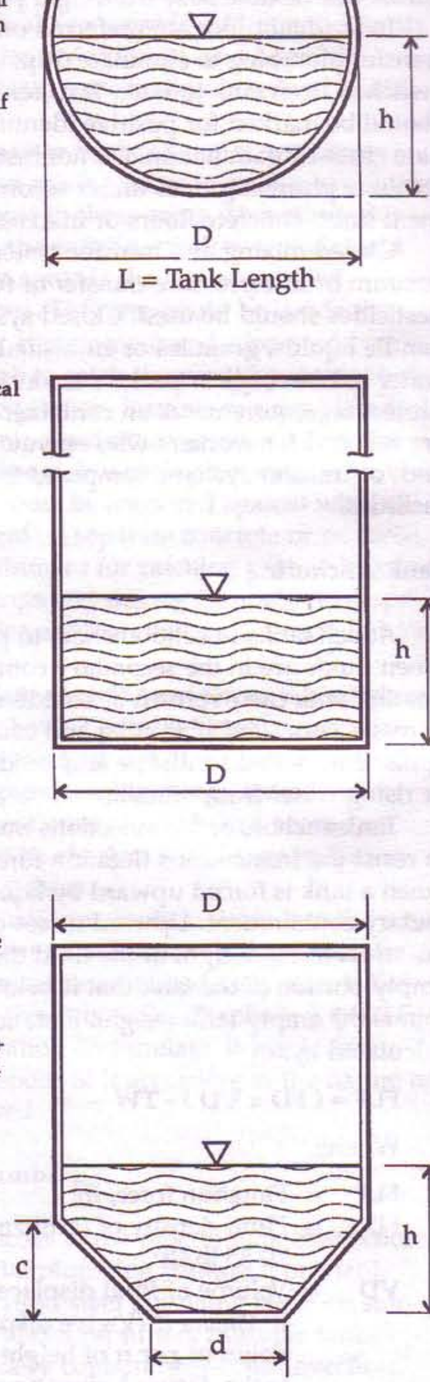

Figure 3. Equations for tank volumes.

Containment Materials

According to a survey by the NDEQ (Buttermore, 1994), the secondary containment costs were estimated at:

	Construction cost based on containment size	
Liner Material	3,000 gallons	5,000 gallons
Concrete	$910-1,930	$1,280-2,700
Synthetic	$800-1,605	$1,130-2,260
Prefab. Bent.	$560-1,120	$775-1,550
Soil	$275-550	$325-650
Tank-in-a-tank	$1,413	NA
Average ($/gal)	$ 0.35/gal	$ 0.27/gal

Concrete Wall and Floor Containment

Concrete has been the preferred material for secondary containment walls and floors. Walls and floors should be designed to support the hydrostatic and gravity loads and to minimize cracking. Watertight concrete must be used to minimize or block chemical leaching through sumps and concrete pads. Watertight specifications and guidelines help ensure proper mixing, placement, reinforcement, joint construction, finishing, curing and future protection. The MWPS-37 Handbook has a chapter on "Concrete" with concrete dimensions, specifications and designs.

The concrete floors to handle ag chemicals should be designed with a minimum 2 percent slope to facilitate washing *(Figure 4)*. Both concrete floors and walls should be protected from chemical attack by using protective coating.

Pesticide and fertilizer can cause severe surface deterioration in just a few days if the surfaces are not thoroughly flushed and cleaned. Sealer materials that will remain flexible for many years during extreme weather cycles should be selected. Flexible epoxies, silicones, urethanes, polyvinylchloride (PVC), neoprene, or Hypalon should be used to counter temperature stress and control sealed joint cracks.

Steel Floors and Walls

Steel can be used to construct the floor and walls of secondary containment, but is usually not recommended unless sealed by epoxy, polyurea or other suitable bonding sealant. Otherwise steel corrodes when exposed to ag chemicals. Corrosion of mild steel is a problem where steel contacts moist soil and under tank bottoms where inspection is difficult and where liquids can congregate.

Storage tanks should be elevated on spacers (like pressure preservative treated lumber). These containments should be designed by an engineer to resist hydrostatic and tank loads. Coat the inside and outside of mild steel tanks with a heavy duty, chemical resistant sealant. Stainless steel works well, but is expensive.

Fiberglass or Plastic Walls and Floors

Rectangular or square, shallow (18-36 inch high) fiberglass open containment tanks are available that

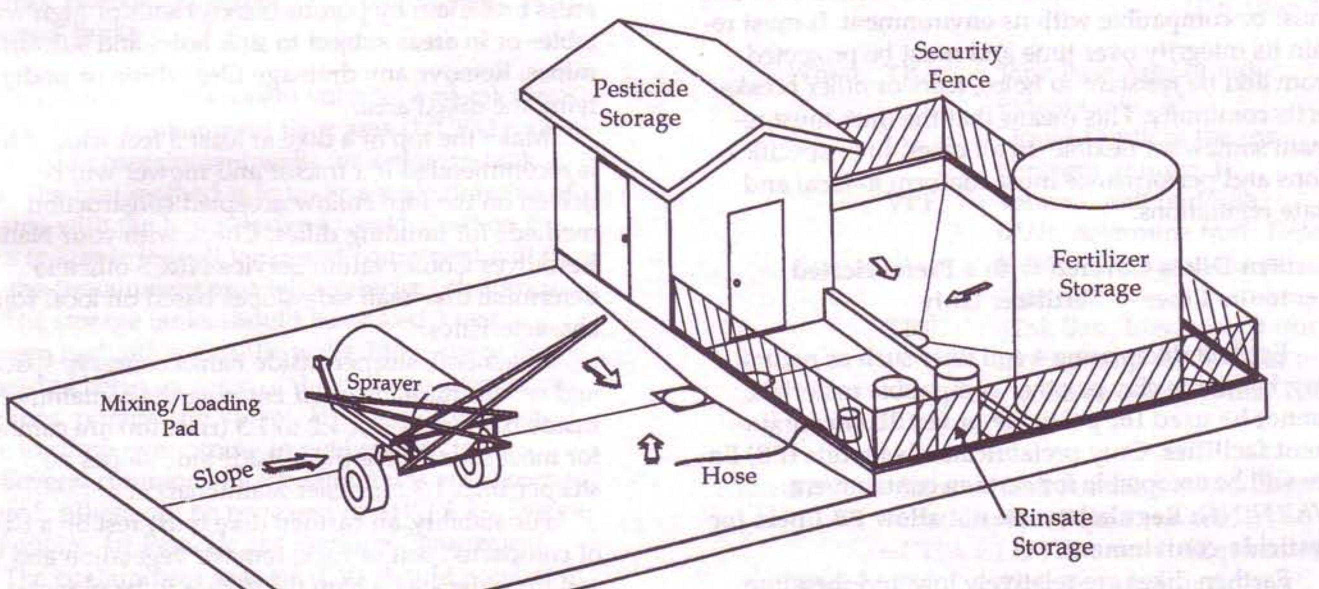

Figure 4. Provide adequate slope in the containment area to facilitate cleaning.

can contain one to four small storage tanks. These work well for containing fiberglass or polyethylene tanks up to 15 ft diameter with 20-25 ft heights.

A smooth base of concrete or compacted soil with a level sand overlay is required to support fiberglass containments. Fiberglass or plastic containments used within a building are susceptible to melting in the event of a fire. This would leave the storage without secondary containment at a time when one would be needed.

Synthetic Liners with Concrete or Composition Walls — Fertilizer Only

For fertilizer storage, synthetic liners (e.g. synthetic rubber, EPDM, polyurea, Hypalon) can be used to repair concrete containments with cracks or can be used in new construction in conjunction with an earthen floor and a concrete or other type of wall for vertical support. The synthetic liner on the floor is sometimes protected by a layer of sand or smooth gravel, which will become contaminated in the event of a spill. Once the protective granular cover is contaminated, any precipitation in the containment area also is contaminated.

It may be possible to decontaminate large (1-1.5 inch diameter), smooth gravel by flushing with a large amount of water. The flush water would have to be treated as contaminated. Otherwise, the granular fill would have to be replaced and the contaminated material disposed of properly. It is difficult to remove the gravel without damaging the synthetic liner.

Install synthetic liners as recommended by the manufacturer to prevent punctures and tears. Choose a liner that is chemically resistant to all the fertilizers stored in the containment area. An effective liner also must be compatible with its environment. It must retain its integrity over time and must be protected from and be resistant to holes, tears or other breaks in its continuity. This means that the liner must remain somewhat flexible. In all cases, liner specifications and performance must conform to local and state regulations.

Earthen Dikes Covered with a Prefabricated Bentonite Liner — Fertilizer Only

Earthen dikes using a soil liner such as natural clay, bentonite clay or other compatible materials, **cannot be used for pesticide or fertilizer containment facilities.** Only prefabricated bentonite (PB) liners will be acceptable for earthen containment. **WARNING: Regulations do not allow PB liners for pesticide containment.**

Earthen dikes are relatively low and therefore may need to occupy a large area to provide a large containment volume. This system requires more land area than containments with vertical walls because of the berm slopes and top widths. Earthen dike containment is usually formed by excavating earthen berms so they may be partly above and below grade.

The containment dike may be located downslope from the storage on sloping sites that would facilitate the fitting of the containment structure within various topographies. On relatively level sites, PB liners can be laid over a graded, ground-level site with earthen berms to form the required containment volume.

To obtain an adequate base for the PB liner, remove the topsoil and then compact the subsoil. Coarse materials, such as sand or gravel, and tree roots or other debris must be removed and disposed of. Do not incorporate vegetation and debris removed from the containment area into the embankment construction.

The PB liner must be installed in accordance with the manufacturer's recommendations. Many PB liners must be kept moist, so installation of an irrigation system and surface moisture management may be critical to containment success.

Some PB liner construction extends the liner over the top of the dike wall. However, the PB liners should cover the area inside the dike and up the inside slope of the dike to the top of the dike. The top of the dike should be at least three foot wide and the sides should slope no more than one foot for each two feet (1:2) of run. A six inch layer of smooth gravel should be placed over the clay liner to protect it from erosion and desiccation. Periodic wetting may be required to prevent the PB lining from separating.

Earthen Dike Design

New storage facilities should not be located in areas underlain by porous (sandy) soils or high water tables or in areas subject to sink holes and subsurface mines. Remove any drainage tiles within or underlying the diked area.

Make the top of a dike at least 3 feet wide; 8 feet is recommended if a tractor and mower will be driven on the top. Follow accepted construction methods for building dikes. Check with your Natural Resources Conservation Service-NRCS office to determine dike wall side-slopes based on local soil characteristics.

In general, steeper inside banks conserve space and reduce rainfall runoff entering the containment. Inside bank slopes of 1:2 to 1:3 (rise:run) are common for most soils. Make the outside side-slopes no steeper than 1:3 for easier maintenance.

For stability, an earthen dike must rest on a base of compacted soil or rock; remove vegetation and top soil from the area where the dike is to be placed. Compact the dike and protect it from erosion. If the slope is 1:2 or less, grass is sufficient protection on the exterior wall of the dike.

Effective erosion control on earthen embankments requires both seeding and riprap or an equivalent alternative. Seed dikes from the outside toe up the embankment face and across the embankment top.

The most satisfactory seeding of embankments is with hardy, short, spreading perennial grasses that are kept mowed. Do not use alfalfa or other deep-rooted crops because the roots destroy the water-holding capacity of the dike.

For the interior slope (the earthen wall within the containment structure), cover the dike with riprap, flat road stone or a similar crushed stone material. Cover the floor of the containment area with a layer of gravel or crushed stone at least 2 inches thick. This layer protects the dike and floor from erosion in the event of a massive tank failure.

Diked areas must not have outlets or drains. Slope the containment floor to a collecting point where precipitation can be pumped to a storage tank for proper disposal.

Earthen dikes present other maintenance problems. Burrowing animals can destroy the integrity of an earthen dike. Dirt, weeds and trash also accumulate in the gravel and result in continuous housekeeping and maintenance problems. In the event of a spill, the interior of the dike will be contaminated.

Once a soil liner is contaminated, it may be necessary to replace the liner or provide routine monitoring. Without adequate remediation, subsequent precipitation becomes contaminated and must be disposed of according to state and local regulations.

Calculation of Containment Size

Vertical, Horizontal, Spherical, Cone-Bottom, and Elevated Tanks

To calculate containment volume, first calculate the minimum containment floor area (MCFA) dimensions inside containment walls for a storage tank field. The best method is to make a scale drawing of the area with the tanks drawn to scale. Position the tanks to assure that all tanks and equipment will fit into the containment area with sufficient clearance.

The storage tanks should be spaced 3 feet between each other and the walls. More space may be needed between some of the tanks to allow room for pipes, pumps and valves. Workers should not have to climb over piping to get between tanks.

Several common storage tank fields are shown in *Figure 5*, others can be reviewed in *MWPS-37, Designing Facilities for Pesticide and Fertilizer Containment.*

The containment volume (CV) should account for:

1) largest tank volume (LTV) plus 10 percent;
2) if not roofed, volume to contain a 25-year, 24-hr rainfall event (RFV);
3) sum of the other tank base volumes (TBV) located in the containment volume;
4) sum of the tank foundation volumes (TFV) that displace containment volume, some large tanks are placed on elevated bases to avoid flotation problems; and
5) the amount of liquid displaced by equipment, pumps, and plumbing (EV) setting in the containment volume.

Thus, the containment volume (CV) can be determined by:

CV = (LTV x FF) + TBV + TFV + RFV + EV [Equation 2]

Where: **LTV** = Largest Tank Volume, ft^3, a full tank is assumed, (1 gal = 7.5 ft^3)
FF = Freeboard factor, 1.1 for 110 percent of largest tank,
TBV = Sum of the other Tank Base Volumes located in the containment area, ft^3,
= $BV_1 + BV_2 + ... + BV_n$ [Equation 3]

Where: **BV** = Base Volume is the volume displaced by individual tanks located in the containment field, ft^3,
= (TBA x LD) [Equation 4]
or = [VPF x (LD - TBE)] [Equation 5]

Where: **TBA** = Tank Base Area of individual tanks, ft^2,
LD = Liquid Depth in the containment volume, ft,
VPF = Volume/unit of depth, ft^3/ft, determine from *Tables II-IV* or the equations in *Figure 3*,
TBE = Tank Base Elevation, ft (for tanks sitting on the floor or a solid base (e.g. rocks, TBE = 0),

TFV = Sum of Tank Foundation Volumes that displace liquid volume, ft^3,
= (TFA x LD) [Equation 6]
Where: **TFA** = Tank Foundation Area, ft^2,
RFV = Rainfall Volume, ft^3, from a 25-yr, 24-hr rainfall event,
= (MCFA x RF) / 12 [Equation 7]

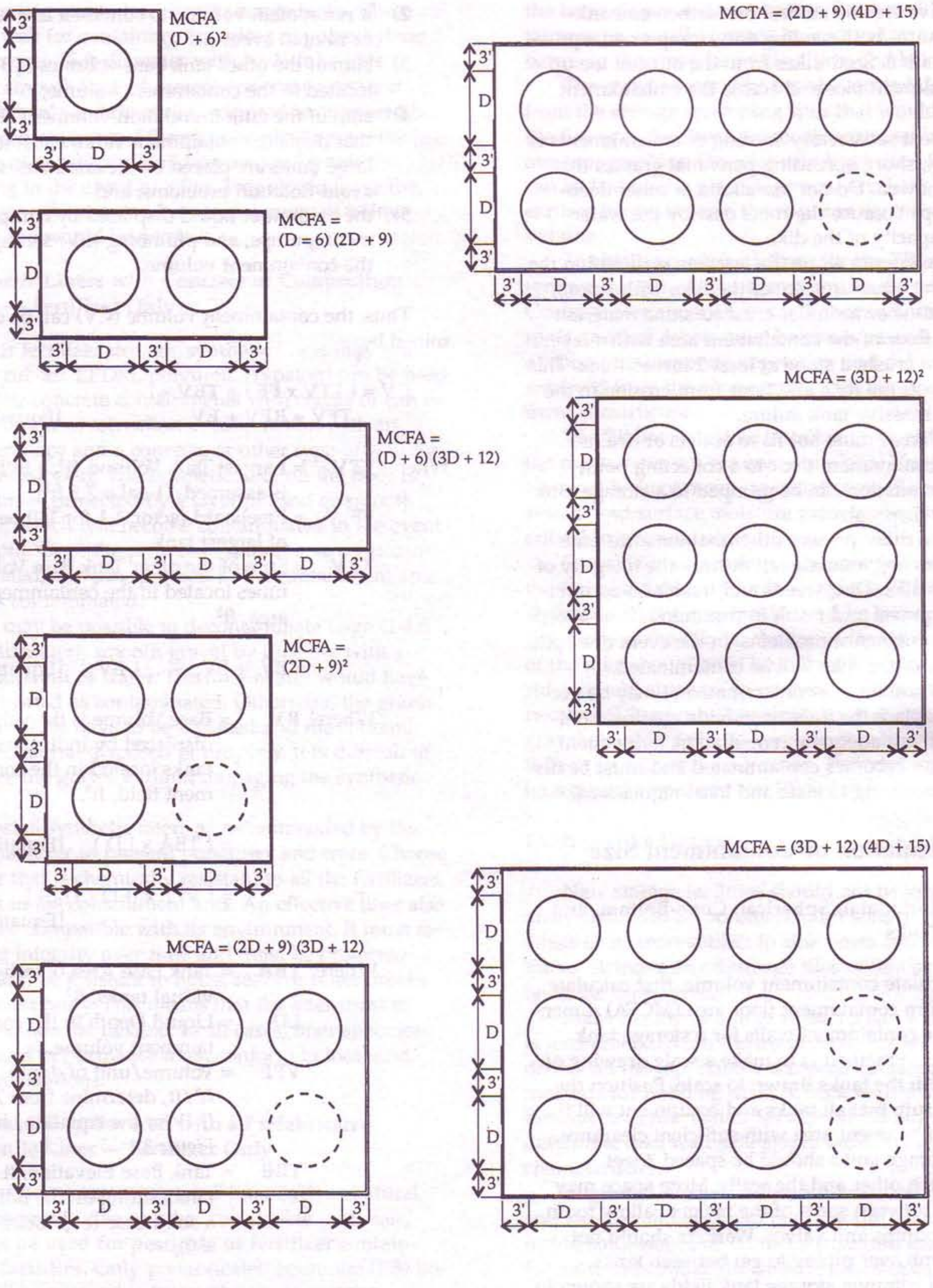

Figure 5. The top view of the Minimum Containment Floor Area (MCFA) of a variety of vertical storage tank fields with common tank diameters.

Where: **RF** = Rainfall amount (See *Figure 1*), inches,

MCFA = Minimum Containment Floor Area, ft^2,

MCFA = FW x FL [Equation 8]

Where:

FW = Floor containment width, ft,

FL = Floor containment length, ft,

EV = Equipment and plumbing volume, ft^3 (the amount of liquid displaced by equipment sitting in the containment area),

Since several of the volume equations are based on liquid depth (LD) in the containment area, an equation for CV can be written as:

CV = [Equation 9]

$$CV = \frac{[\,(LTV \times FF) + EV + (MCFA \times RF)/12 - (VPF \times TBE)\,]}{[\,1 - [\,(VPF + TFA) / MCFA\,]\,]}$$

Note that volume displacement per unit depth (VPF) can be found in *Tables II-IV* or equations in *Figure 3*. The VPF or the foundation volumes (TFV) may not be uniform with depth, so use the most volume displacement per unit depth as a conservative estimate. A tank sitting on a solid base, such as rocks or boards, is not considered elevated because the base support takes up volume. These calculations allow for volume taken up by equipment (EV) in the containment area.

Containment Wall Height

Containment wall height (CD) can be calculated by:

CD = CV / MCFA [Equation 10]

Wall height (CD) should always be greater than the liquid depth (LD). Containment wall height of 3 feet is usually recommended because users can easily see and step over a 3 foot high wall. Higher walls increase tank anchoring requirements and the risk of plumbing ruptures due to tank flotation. If the containment wall height calculated in Equation 10 is too high, then enlarge the MCFA and repeat the sizing steps for determining the containment volume.

Remember, repeating these steps is necessary because the rainfall volume will increase due to a larger floor area. In general, a 3 foot containment wall height is safer, more practical and more functional than a higher wall, although it may be slightly more expensive because of the additional concrete required for a larger floor slab. For an equal containment capacity, a 2 foot wall will result in more floor area than a 3 foot wall. This is offset some by the additional wall area that the deeper section requires.

Savings in concrete area should only be a secondary consideration, after function and safety for secondary containments have been evaluated.

If a wall height greater than 3 feet high is selected, wide steps with hand rails on both sides of the wall may be an adequate solution for worker safety, comfort and convenience. However, safety steps over walls present a continual problem for workers, especially in icy conditions.

Do not put earthen berms against walls unless the walls are designed to withstand the horizontal earth loads. Divert rainwater away from the containment area. Also, the earth could corrode exposed steel and may cause the containment to be defined as an underground storage, which has more restrictive regulations. It is wise to construct containment floors at grade level.

Example 1. Suppose a producer stores fertilizer in two 3,700 gallon vertical tanks. The tanks have a diameter of 8 ft and overall height of 10 ft. These tanks are located in a 4.5 inch rainfall event area. Little equipment is stored in the containment area. What is the recommended floor area and wall height?

Using the recommended walkway clearance, a scale drawing was made *(Figure 6)*. The area needs to be at least 14 ft wide by 25 ft long to allow the 3 ft access area around the two tanks. The MCFA is:

MCFA = 25 ft x 14 ft = 350 ft^2 of containment floor area.

The tanks are filled in 3,700 gallon increments. The volume can be calculated as:

LTV = 3,700 gal X (ft^3 / 7.5 gal) = 493 ft^3

The "area of the base" from the other tank is found in *Table II*, such as:

VPF = 50.27 ft^3 per foot of containment depth

Using Equation 9:

$$CV = \frac{[\,(493\ ft^3 \times 1.1) + 0 + (350\ ft^2 \times 4.5\ in) / 12\ in/ft + 0\,]}{[\,1 - \{(50.27\ ft^3/ft + 0) / 350\ ft^2\}\,]}$$

= 786.5 ft^3 or 5,900 gallons of volume is required for containment.

Containment wall height can be calculated using Equation 10:

CD = 786.5 ft^3 / 350 ft^2

= 2.3 ft

A wall height of 2.5 ft would give sufficient volume to adequately contain a spill from one of the tanks.

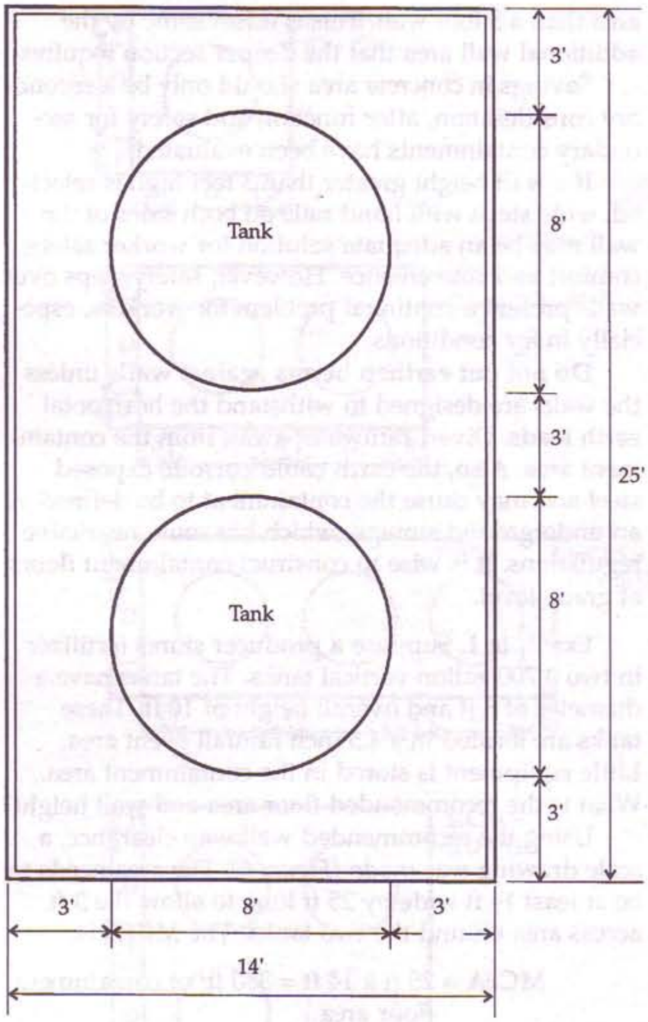

Figure 6. The top view of the Minimum Containment Floor Area (MCFA) for two vertical tanks used in Example 1.

Earthen Dike Sizing

Deep dikes require less floor area for the same containment capacity, but can be more difficult and inconvenient to maintain and operate equipment on. Large earthen containments may need additional freeboard beyond that required for precipitation because wind can create waves that could splash over the dikes. A safety factor should be added to the required liquid volume by increasing a freeboard factor **(FB)**. This additional freeboard is called wave freeboard and should be at least 1 foot, with 2 feet preferred.

First, develop a scaled drawing for the 3 foot access walkways and tank clearance as described earlier. From the scale drawing establish the dimensions for the containment floor. Using these dimensions, calculate the minimum containment floor area by:

$$\mathbf{MCFA = FW \times FL} \qquad \text{[Equation 11]}$$

Where:

FW = floor containment width, ft,
FL = floor containment length, ft,

The containment volume (CV) can be calculated as:

$$CV = (LTV \times FF) + TBV + TFV + RFV + EV \qquad \text{[Equation 12]}$$

Where: LTV, FF, TBV, TFV, EV = defined same as previous.

$$RFV = (EW \times EL) \times RF/12 \qquad \text{[Equation 13]}$$

Where: EW, EL = Earthen basin width and length, ft,

$$EW = FW + 2 \times (FB + LD) \times SS \qquad \text{[Equation 14]}$$

$$EF = FL + 2 \times (FB + LD) \times SS \qquad \text{[Equation 15]}$$

Substituting in for the floor containment length and width, Equation 13 becomes:

$$RFV = [\, MCFA + \{(FL + FW) \times (2 \times SS) \times (FB + LD)\} + \{4 \times (SS)^2 \times (FB + LD)^2\} \,] \times RF/12 \qquad \text{[Equation 16]}$$

Where: RF, LD = defined same as previous,
FB = wave freeboard, ft,
SS = sideslope, ft, amount of run for 1 ft rise,

The actual liquid volume (ALV) found in the containment dike can be calculated as:

$$\mathbf{ALV = (MCFA \times LD) + [\, SS \times (LD)^2 \,] \times [\, FW + FL \,] + [\, 4/3 \times (SS)^2 \times (LD)^3 \,]} \qquad \text{[Equation 17]}$$

For the structure to properly contain a spill, the actual liquid volume must be larger than the containment volume. Because several factors (TBV, TFV, RFV) in Equation 12 are related to the liquid depth, a trial and error method could be used to achieve the criteria, ALV > CV, or the two Equations 12 and 17 can be equated and solved for LD. The resulting equation is a third order equation given by:

$$d = [\, a \times (LD)^3 \,] + [\, b \times (LD)^2 \,] + [\, c \times LD \,] \qquad \text{[Equation 18]}$$

Where:

$$a = [\, 4/3 \times (SS)^2 \,] \qquad \text{[Equation 19]}$$

$$b = [\, (FW + FL) \times SS \,] - [\, 4 \times (SS)^2 \,] \times (RF/12) \qquad \text{[Equation 20]}$$

$$c = MCFA - (TBA + TFA) - [\, (FL + FW) \times (2 \times SS) \,] - [\, 8 \times FB \times (SS)^2 \,] \qquad \text{[Equation 21]}$$

$$d = EV + (LTV \times FF) + [\, MCFA \times (RF/12) \,] + [\, 2 \times SS \times (FL + FW) \times FB \times (RF/12) \,] \qquad \text{[Equation 22]}$$

Since solution of a cubic equation is difficult, the third order term will be considered small and Equation 18 will be solved as a quadratic. With this assumption the quadratic solution is:

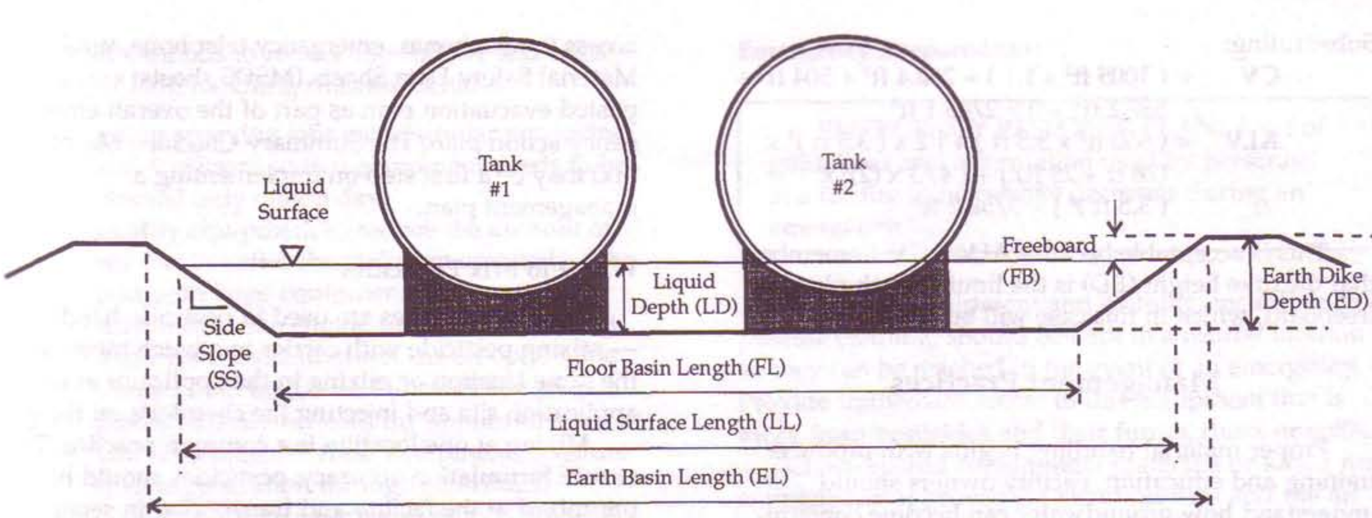

Figure 7. Earthen dike definitions and the side view of two horizontal tanks used in Example 2.

LD = [- c + SQRT{ (c)² + (4 x b x d) }] / [2 x b] [Equation 23]

Using this approach, the solution for liquid depth (LD) should be conservative, but the solution should be checked by substituting the LD into Equations 12 and 17 and reconfirming that ALV > CV. The actual dike height (ED) will be the liquid depth (LD) plus the freeboard (FD) as shown in *Figure 7*.

Example 2. Suppose that an earthen dike is needed to contain two horizontal fertilizer tanks that are 8 ft diameter and 20 ft long. The 7,500 gallon tanks are set 1 ft off the ground on concrete supports (*Figure 7*). The foundation volume takes up 144 ft³ per ft of depth. Assume the freeboard (FB) is 1 ft and the inner side slopes are 1:2. The RF is 5.5 inches.

From *Table II*, the tank volume is:

LTV = 50.27 ft³/ft x 20 ft
1,005.4 ft³ per tank

The minimum containment floor area (MCFA), using the 3 ft walkway and clearance guidelines, will be an area 25 ft by 26 ft (*Figure 8*). The MCFA is:

MCFA = 25 ft x 26 ft = 650 ft²

For conservative purposes, assume the tank displacement from *Table III*, so:

TBA = 6.74 ft³/ft x 20 ft = 135 ft³/ft or 135 ft² per unit depth

So substitute the information in Equations 20-22:

b = [(26 ft + 25 ft) x 2] - [4 x (2)²]x(5.5 in / 12 in/ft) = 94.7

c = 650 ft² - (135 ft² + 144 ft²) - [(26 ft + 25 ft) x (2 x 2)] - [8 x 1 ft x (2)²] = 135.0

d = 0 + (1005 ft³ x 1.1) - [650 ft² x (5.5 in / 12 in/ft)] + [2x2x(26 ft + 25 ft)x1 ftx(5.5 in / 12 in/ft)] = 1,497.0

Now substituting into Equation 23:

LD = [-135 + SQRT{ (135)² + (4 x 94.7 x 1497.0) }] / [2 x 94.7] = 3.33 ft

Try a liquid depth of 3.5 ft, by substituting in Equations 12 and 17. Using *Table IV* and a depth of fluid displaced of 2.5 ft (from 3.5 ft minus 1.0 ft tank elevation). The TBV and other factors become:

TBV = 13.42 ft³/ft x 20 ft = 268.4 ft³
TFV = 144 ft³/ft x 3.5 = 504 ft³
RFV = { 650 ft³ + [(26 ft + 25 ft) x2x2x (1 ft + 3.5 ft)] + [4 x 2² x (1 ft + 3.5 ft)²] } x (5.5 in / 12 in/ft) = 867.2 ft³

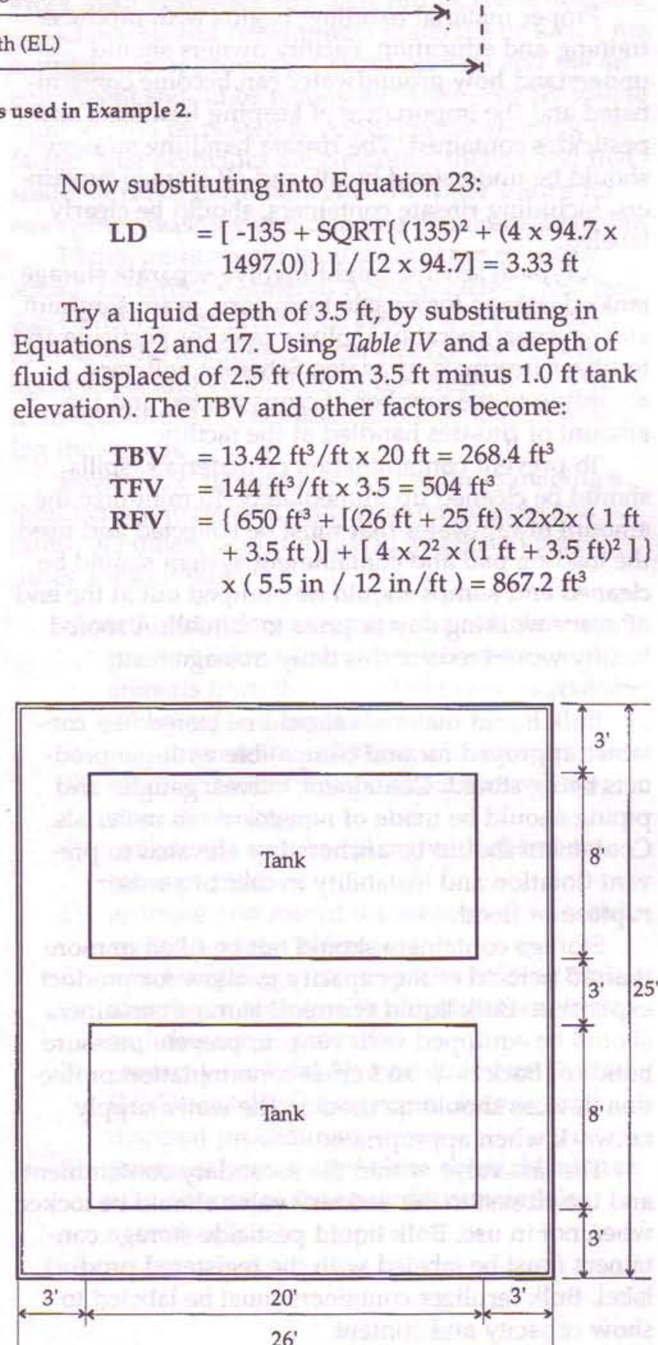

Figure 8. The top view of the Minimum Containment Floor Area (MCFA) for two horizontal tanks used in Example 2.

Substituting:

$$CV = (1005\ ft^3 \times 1.1) + 268.4\ ft^3 + 504\ ft^3 + 867.2\ ft^3 + 0 = 2745.1\ ft^3$$

$$ALV = (650\ ft^2 \times 3.5\ ft) + [\,2 \times (3.5\ ft)^2 \times (26\ ft + 25\ ft)\,] + [\,4/3 \times (2)^2 \times (3.5\ ft)^3\,] = 3753.2\ ft^3$$

This is acceptable because ALV > CV. Remember that the dike height (ED) is the liquid depth plus the freeboard, which in this case will be 4.5 ft.

Management Practices

Proper material handling begins with producer training and education. Facility owners should understand how groundwater can become contaminated and the importance of keeping fertilizers and pesticides contained. The rinsate handling strategy should be understood by all, and all storage containers, including rinsate containers, should be clearly labeled.

A typical scheme might involve separate storage tanks designed for rinsate from corn, grain sorghum, and soybean operations, plus a tank for pesticide and fertilizer free makeup water. Schemes will vary according to the number of crops treated and the amount of rinsates handled at the facility.

To prevent contamination of materials, spills should be cleaned up immediately. To minimize the amount of rainwater that must be collected and used, the loading pad and containment system should be cleaned and sumps should be pumped out at the end of every working day or prior to rainfall. A roofed facility would reduce this daily management problem.

Bulk liquid materials should be stored in a container approved for and compatible with the products being stored. Containers, valves, gauges, and piping should be made of non-corrosive materials. Containers should be anchored or elevated to prevent flotation and instability in case of a major rupture or flood.

Storage containers should not be filled to more than 95 percent of the capacity to allow for product expansion. Bulk liquid chemical storage containers should be equipped with vents to prevent pressure buildup. Back flow and cross-contamination protection devices should be used on the water supply network when appropriate.

The last valve within the secondary containment and the closest to the delivery valve should be locked when not in use. Bulk liquid pesticide storage containers must be labeled with the registered product label. Bulk fertilizer containers must be labeled to show capacity and content.

Other items for management consideration are: identify building "uses" (both current and future intentions), and how the facility will have immediate access to telephones, emergency telephone numbers, Material Safety Data Sheets (MSDS sheets) and a posted evacuation plan as part of the overall emergency action plan. The Summary Checklist (Appendix) may be a first step on implementing a management plan.

Where to Mix Pesticides

Three approaches are used in pesticide handling — mixing pesticide with carrier in a batch mixer at the same location or mixing in the applicator at the application site and injecting the chemicals on the go.

Mixing at one location is a common practice. To ensure formulation accuracy, pesticides should be pre-mixed at the facility and transported in separate containers on nurse equipment. The containers should be approved by the DOT (Department of Transportation) for transporting pesticides.

Formulation accuracy is enhanced because all mixing can be done under controlled conditions with the information close at hand. Less equipment is needed because pesticides are not mixed and handled in equipment separate from fertilizer.

The main disadvantage of one site mixing is the amount of equipment that must be cleaned to prevent contamination when switching products. All equipment (mix tanks, nurse tanks and application equipment) must be purged of the particular product. Another disadvantage is the hazards associated with the transport of large volumes of agricultural chemicals.

Some producers wait to mix pesticides when they are in the field. Pesticide is mixed with fertilizer in the applicator. Pesticide-laden rinsates can be practically eliminated if the applicator is rinsed in the field.

Another system keeps pesticides outside the applicator and adds them to the applicator's outstream by an inboard injection or impregnation system. These systems are near ideal for reducing rinsates; however, direct injection systems are limited in the number of products they can handle.

Regardless of where pesticides and fertilizers are mixed, the amount of rinse water handled at the containment location can be reduced by rinsing as much equipment as possible in the field where application occurs. To reduce the chance of contaminating surface water, rinsing should be done well away from ditches, streams, creeks, and surface waters.

Rinsate Handling Tips

> RINSATE: Water and sometimes solids, contaminated with pesticides or fertilizer of relatively low concentration. Resinate becomes a waste if it cannot be used according to the product label.

Other methods to reduce the volume and costs associated with handling rinsates include:

1) group spraying jobs using similar pesticides and fertilizers so that equipment needs to be cleaned only once a day;
2) modify equipment to reduce the amount of residue left after the tanks are emptied — the pump on large equipment, for example, is driven from the engine that is nearly 10 feet away from the tank drain. As an option, the pump could be driven hydraulically and placed directly beneath the applicator tank.
3) Use high pressure rinse equipment to reduce rinsate generation through centrifugal pumps. Though centrifugal pumps are well suited for handling fertilizer, their high output-low operating pressure make them poorly suited for washing out equipment. A high pressure washer cleans better with less water.
4) Calibrate equipment properly and know the exact acreage to be treated. This will minimize the amount of pesticide mixture that must be either rinsed from the applicator or hauled back for recycling.

On-board rinse systems with nozzles mounted inside the applicator tank are available to clean the tank walls and valves. Applicator rinsate from on-board rinse systems should be broadcast over the field just sprayed and not dumped at one location. Portable sprayers also are available for cleaning pesticide residues from inside and outside the applicators.

Chemical Security

Pesticide, fertilizer and resinate storage and containment areas should be secured by heavy chain-linked fencing with locked access or be inside locked buildings. Fencing mounted flush with outer containment walls should have at least 6 feet combined height. Empty disposable containers should be stored in a secure area.

> According to a 1993 survey by the Biological Systems Engineering Dept. (Reed et al., 1994), 39 percent of the farmers used greater than 200 gallons of pesticides each year. Majority of the farmers (66 percent) purchased pesticides in 1 or 2.5 gallon containers. Implication — farmers have about 100 containers for disposal.

Emergency Preparedness

> EMERGENCY RESPONSE PLAN: A set of guidelines and information used by personnel at a facility to help make decisions during an emergency.

Protective equipment and clothing, including disposable clothing, should be kept in a nearby location so they can be reached in the event of an emergency. Provide immediate access to this equipment that is away from pesticides and their fumes, dusts or spills.

Clean-up and containment materials or kits, a fire extinguisher approved for chemical fires and fire air equipment should be readily available. Highly visible signs should be posted to notify people entering the facility that pesticides are contained therein and that smoking is not permitted. A clean water source for emergency washing and cleaning should be available.

Phone numbers for local ambulance or rescue squad, Hazardous Material Agency, NDEQ, and poison control center should be posted in a prominent spot near the telephone. Local emergency response agencies should be notified of the presence and maximum quantities of chemicals in the containment during the season.

Review the standard procedure for managing a liquid concentrate spill with your employees and family members, and practice it! Suggested procedures are as follows:

1) tell bystanders to remain at a safe distance to prevent injuries, remove all livestock and animals from the immediate area, and tend to any injured persons;
2) put on protective clothing and equipment;
3) rotate container to a position that will stop or slow the leakage;
4) contain the spill by diking with absorbent tubes or pillows;
5) estimate and record the amount or material spilled for later reference;
6) remove spillage into a special holding tank, absorb remaining with absorbent materials and dispose of properly;
7) contact your local Natural Resource District (NRD) or NDEQ for proper clean-up and disposal procedures;
8) thoroughly wash and clean the incident area and dispose of the hazardous materials accordingly.

Storage and Handling — *Pesticides* (continued)	Yes	No
• If pesticide tanks are under a roof, is the containment volume adequate to hold at least 110 percent of the largest single tank within the containment area (taking into consideration the displacement volume of all tanks and equipment within the area)?	☐	☐
• If the containment area is not under a roof, is the containment volume adequate to hold the volume of the largest single tank within the containment area (taking into consideration the displacement volume of all tanks and equipment within the area), plus freeboard and rainfall amounts as prescribed by state regulations?	☐	☐
• If the pesticide containment area is outside, do you have plans to bring it under a roof?	☐	☐
• Are all pipes, hoses and valves located within a containment structure?	☐	☐
• Are these inspections documented?	☐	☐
• Are inspections filed on site?	☐	☐
• Are leaks repaired immediately?	☐	☐
• Are spills immediately cleaned up and the waste disposed of properly?	☐	☐
• Is the containment area equipped with a spill collection sump and holding tank?	☐	☐
• Are all pesticide mini-bulk tanks stored in an area that would prohibit run-off into streams, ditches or well heads?	☐	☐
• Are contained fluids reused in product mixes?	☐	☐
• Are packaged chemicals stored inside a secure building designed to hold water or other chemicals used in fire extinguishing?	☐	☐
• Are all pesticide containers kept closed except during transfer operations?	☐	☐

Storage and Handling	Yes	No
Mixer and Loadout Areas		
• Is the mixer located within a containment area capable of holding its contents?	☐	☐
• Is all product loading done over a loadout pad with a collection sump?	☐	☐
• Can the loadout pad containment system handle the volume of the largest transport truck?	☐	☐
• Is the loadout pad constructed in a manner to prevent excessive drainage of a rainwater runoff into its collection sump?	☐	☐

Rinsate Handling and Reuse	Yes	No
• Is all equipment field-rinsed?	☐	☐
• Is any equipment rinsed at the facility upon return from the field?	☐	☐
• If rinsed at the facility, is rinsate collected and reused?	☐	☐
• Is rinsate segregated by crop type to facilitate reuse?	☐	☐
• Is all on-site equipment washdown done on a rinse pad?	☐	☐
• Is all washwater/rinsate collected and reused?	☐	☐

Storage and Handling — *Rinsate Handling and Reuse* (continued)	Yes	No
• Is a pump available for emptying the rinse pad sump?	☐	☐
• Is the liquid collected from the rinse pad sump stored in an above-ground tank?	☐	☐
• Is the rinsate storage container connected to a mix tank to facilitate reuse?	☐	☐

Safety and Security	Yes	No
Employee Safety		
• Are employees and family members trained in proper handling and spill response of fertilizer and pesticide products?	☐	☐
• Are employees and family members trained to use protective clothing, eye protection and safety equipment?	☐	☐
• Do you have frequent, regularly scheduled safety meetings and training?	☐	☐
• Are eye washes, safety showers, respirators and other personal protective gear and equipment readily available and in good working order?	☐	☐
• Do all persons use appropriate protective gear and equipment when handling products?	☐	☐
• Have all persons been given instructions that there will be no smoking or eating while handling pesticides?	☐	☐
• Do you have Material Safety Data Sheets (MSDS) for all hazardous materials (such as pesticides, ammonia or acids) used?	☐	☐
• Are the MSDSs readily available to all persons?	☐	☐
• Is the mixing area properly ventilated for hot mixing and pesticide handling?	☐	☐
• Are appropriate warning signs regarding hazardous chemicals and no smoking areas prominently displayed?	☐	☐
• Are all product storage tanks labeled properly by content?	☐	☐

Safety and Security	Yes	No
Site Security		
• Do you have a security fence or other means of preventing unauthorized public access to your property?	☐	☐
• Are all gates lockable and locked when your facility is unattended?	☐	☐
• Are valves on bulk product tanks secured with locks?	☐	☐
• Have sight gauges on tanks been eliminated or equipped with bottom valves that are normally locked?	☐	☐
• Are all sump pumps or drains from containment areas locked?	☐	☐
• If application equipment containing product is stored overnight, is it equipped with locked discharge valves?	☐	☐
• Do you have adequate lighting in all product storage and handling areas?	☐	☐