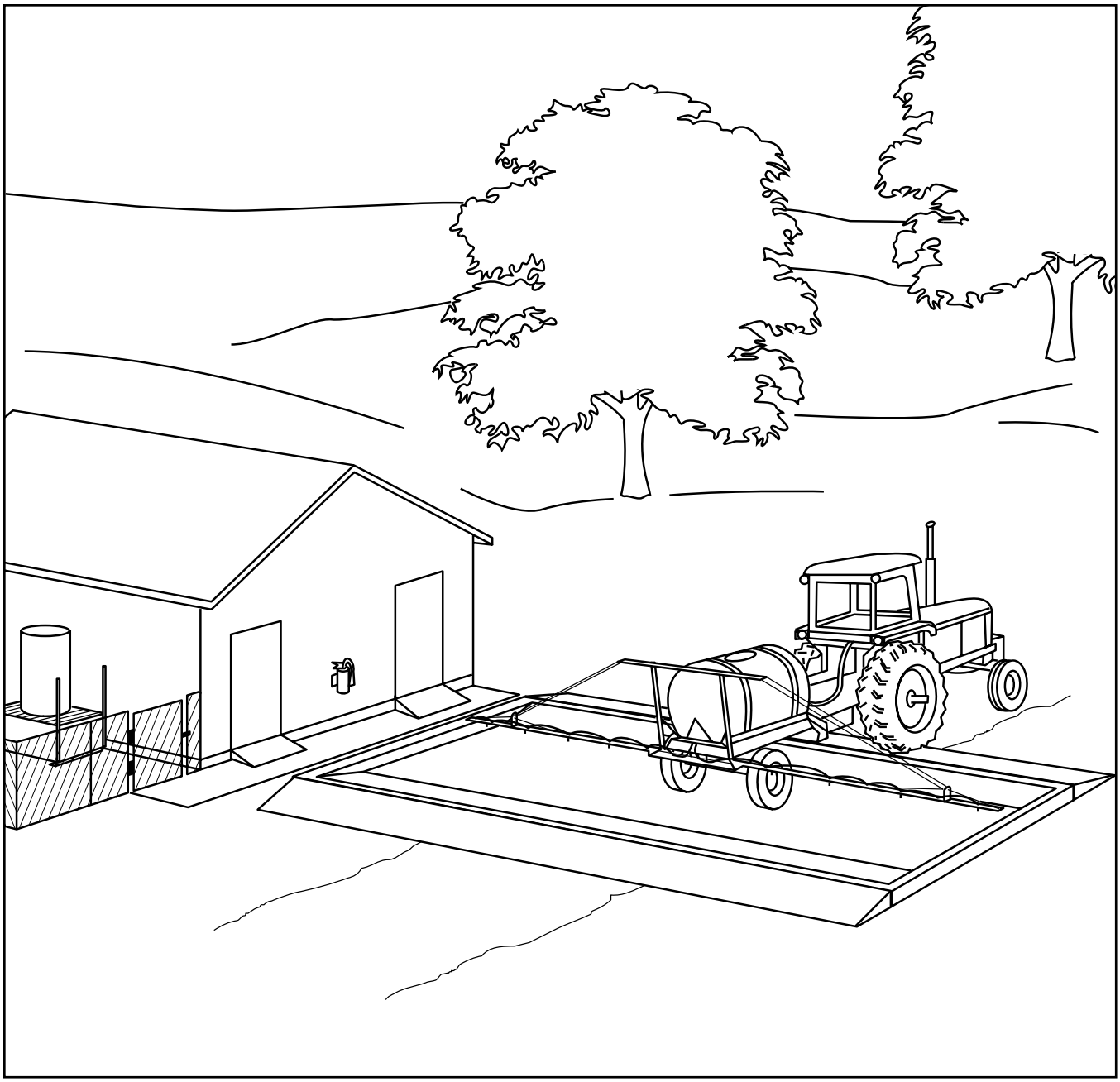
NRAES–78

On-Farm Agrichemical Handling Facilities



Natural Resource, Agriculture, and Engineering Service
Cooperative Extension

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On-Farm Agrichemical Handling Facilities

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Table of Contents

List of Tables

List of Figures

Introduction

Environmental and human safety concerns require that agricultural chemicals be stored and handled in a safe manner. Federal and state governments also have guidelines for the storage and handling of pesticides. Specific storage requirements for each pesticide are given in the Material Safety Data Sheet (MSDS) and on the pesticide label.

Before building a storage, a farmer should consider the need for keeping an inventory of chemicals and whether they need to be stored over winter. In larger operations, consideration should be given to using custom application or to purchasing pesticides in bulk, returnable containers that reduce storage and handling risk. Custom application refers to hiring a company that specializes in chemical application to apply necessary chemicals. The need for agrichemical handling facilities will be determined by the agreement with the custom applicator. In many cases, though, a separate storage area or building where chemicals are mixed and equipment is filled and cleaned is necessary.

Before construction begins, discuss plans with local agencies concerned with planning and zoning, wetlands, health, and fire. Health and safety concerns can be addressed by providing an MSDS for each pesticide stored, along with information on the quantity to be stored, application rate, and application frequency.

Good storage practices are important to be able to locate materials when they are needed, to keep unauthorized persons from having access to the chemicals, and to avoid deterioration and loss of pesticide effectiveness. Separating herbicides, fungicides, and insecticides avoids cross-contamination from leaks or fumes. Storage problems can be minimized by purchasing only the amount required for a specific crop.

Chemical mixes should be prepared in the quantities needed by the crop. Very little or no chemical mix should normally return to the storage/mixing facility. Rinsate from cleaning sprayers and pad washing should be kept to a minimum. Rinsate should be stored separately according to the type of chemical it contains and should be used in new chemical mixes being prepared. Containment and rinsate utilization are important goals.

Principal Parts of the Facility

A well-designed handling facility has four components: storage room; mixing room; safety equipment, records, and locker room; and an area for equipment loading/rinsing that will contain any spills (figure 1, page 2). Each farmer must determine the requirements for each of the four parts and the overall layout of the facility based on the farm size and the types and quantities of pesticides used. A small or single crop farm may have a one-room facility, while a larger or diverse crop operation may have separate spaces for each of the four components.

Storage Room

The storage room keeps pesticides cool and dry and out of direct sunlight. It should have doors to prevent air flow from the storage room to worker areas. Where pesticides are stored in large quantities, a separate room is desirable to hold herbicides separate from other pesticides. Where smaller quantities are stored, the pesticides should be separated by type and stored on shelves in plastic, leakproof trays. Quantities of bagged chemicals must be kept off the ground on pallets. Cans and drums of liquid chemicals should be placed on spill containment pallets (figure 2, page 2). Fertilizers should be kept separate from pesticides in a separate storage area.

A storage room should have its own environment control system to keep the temperature between 40°F and 100°F. Ventilation is needed to remove fumes and odors that may escape from the containers. In Northern climates, the ventilation rate may be reduced during the heating season to conserve energy. The room must be well ventilated before entry.

Heat should be provided to maintain minimum storage temperatures and for employee comfort. If flammable chemicals are stored, do not use a combustion-type heater. A resistance electric heater works well.

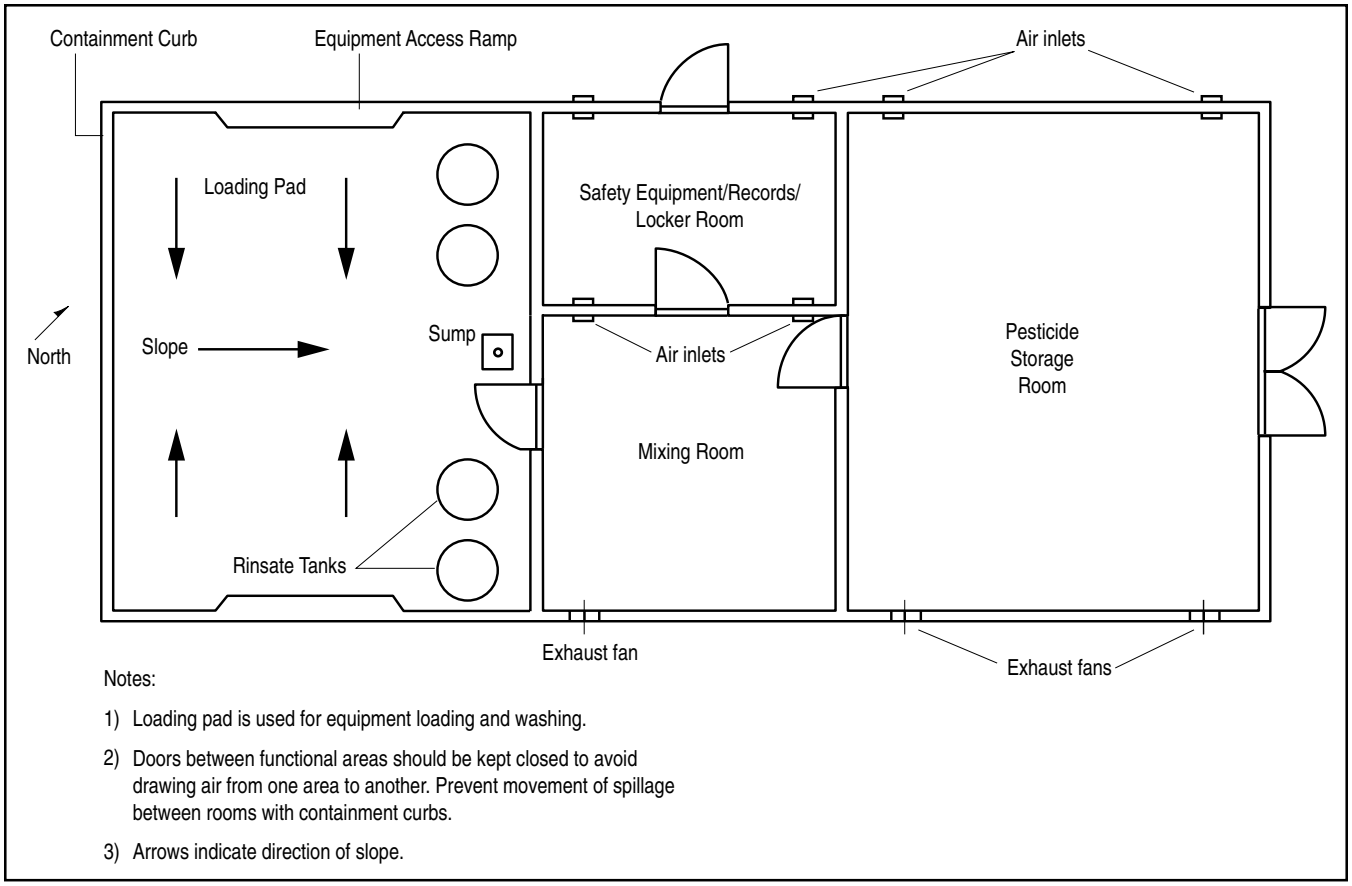


Figure 1. Components of a chemical handling facility.

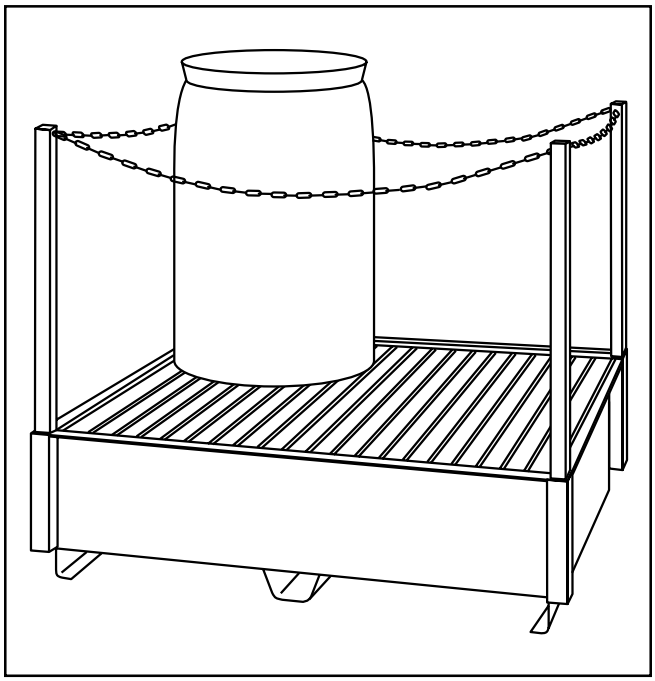


Figure 2. Spill containment pallet.

Mixing Room

The mixing room contains a work surface with scales, measuring cups and spoons, and buckets. A water supply and sink are needed for chemical preparation and cleanup. Even though protective gear will be worn, employees should wash their hands after handling pesticides. Cleaning agents should be available.

A backflow prevention device should be installed to protect the water supply. The sink drains to a sump where the contaminated water is collected and pumped into a tank where it is stored for use in subsequent spraying operations or for disposal as a hazardous waste. Pesticide recommendations and application records may be kept here but are better stored outside of the mixing room to avoid water damage or chemical contamination. The size and design of the facility will dictate where some procedures occur.

Continuous ventilation is necessary to avoid buildup of toxic gases. This can be provided by strategically placed openings to the outside or by a

combination of openings and a low-speed fan. The continuous ventilation system should be supplemented by additional fan capacity. Before entering the mixing room, turn on the additional fans and let them run for at least one room volume air change or ten minutes.

A fume hood over the mixing table or space will draw fumes away from workers. A motorized intake louver, sized to the dimensions of the facility, should be installed in a door or wall opposite the fume hood to let in air. Specific ventilation details are discussed later.

To contain all spills within the room, the floor should be sloped toward a common sump in the corner of the room or edge of the equipment loading area. A concrete berm around the room for containment and a sloped door sill are part of most installations (figure 3).

Safety Equipment, Records, and Locker Room

A separate clean room or set of cabinets within the facility is recommended for storing clean personal clothing including coveralls, gloves, boots, and respirators. Shower and toilet facilities may or may not be included, but there should be a place to dress that is free from chemical vapors.

Outside ventilation air can be drawn through this room and then through the mixing room to keep odors and vapors from contaminating the records room (see figure 1, page 2). A small office or record-keeping desk or counter surface should be available. Keep one set of spray records here; a second set should be filed away from the facility. Material Safety Data Sheets (MSDSs) for all chemicals at the facility should be available in this room. A phone placed here or in the mixing room provides quick response in an emergency. This space should have an outside door so that employees are not trapped in an emergency.

Equipment Loading/Rinse Pad

The loading pad is a containment area where the loading and unloading of sprayers and spreaders take place (figure 4, page 4). It is also used for washing the equipment after the chemical application is complete. The pad collects and contains rinsate and any chemical spills. A drench shower and eye wash station could also be located here (figure 5, page 4). If chemicals are spilled on workers, this equipment will minimize the risk of serious injury.

In facilities used primarily during warm weather, such as for field crop, fruit, and nursery operations, the mixing of the pesticides may take place on the loading pad. Pre-measured packets or containers of chemicals are added directly to the sprayer tank. In other operations, such as greenhouses, the loading of the hand-held, backpack, or mobile sprayers may take place in an enclosed area and may be part of the mixing room.

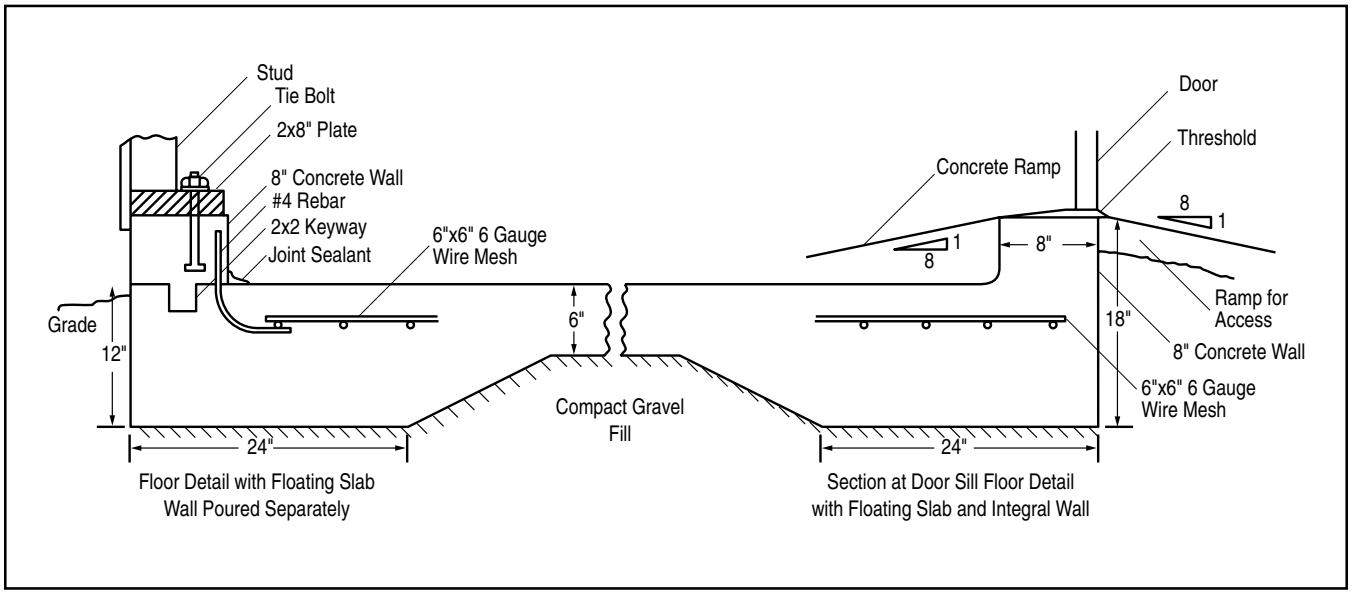


Figure 3. Concrete berm and sloped door sill.

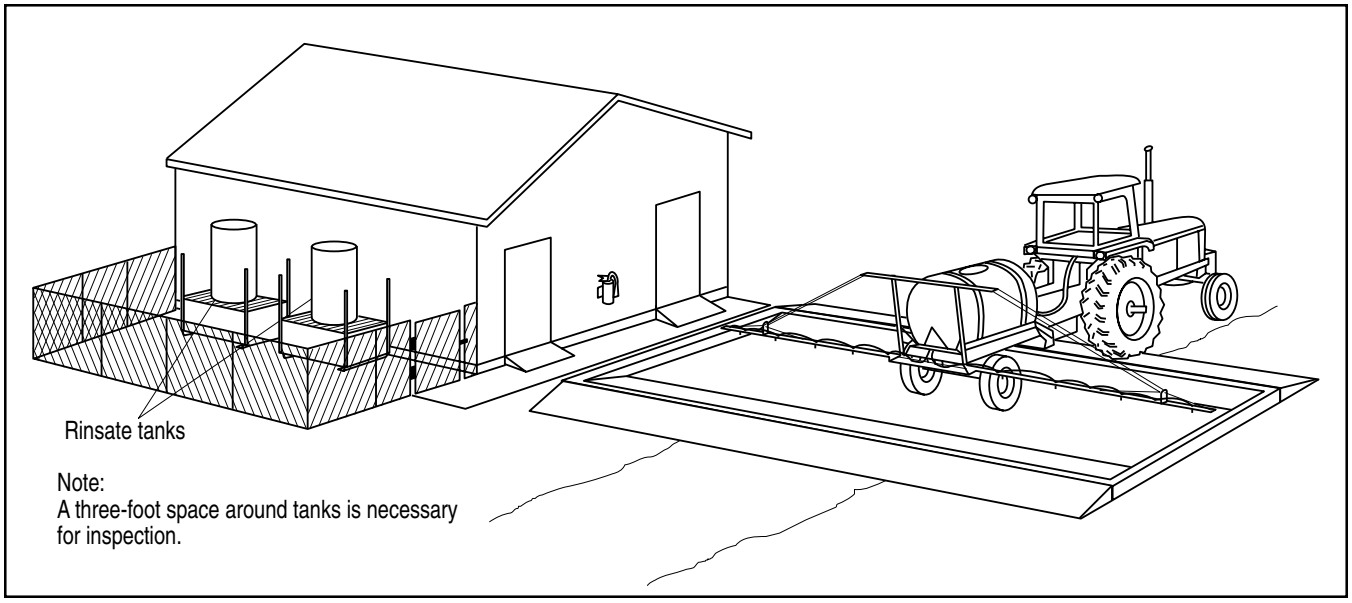


Figure 4. Storage building/containment pad with sprayer.

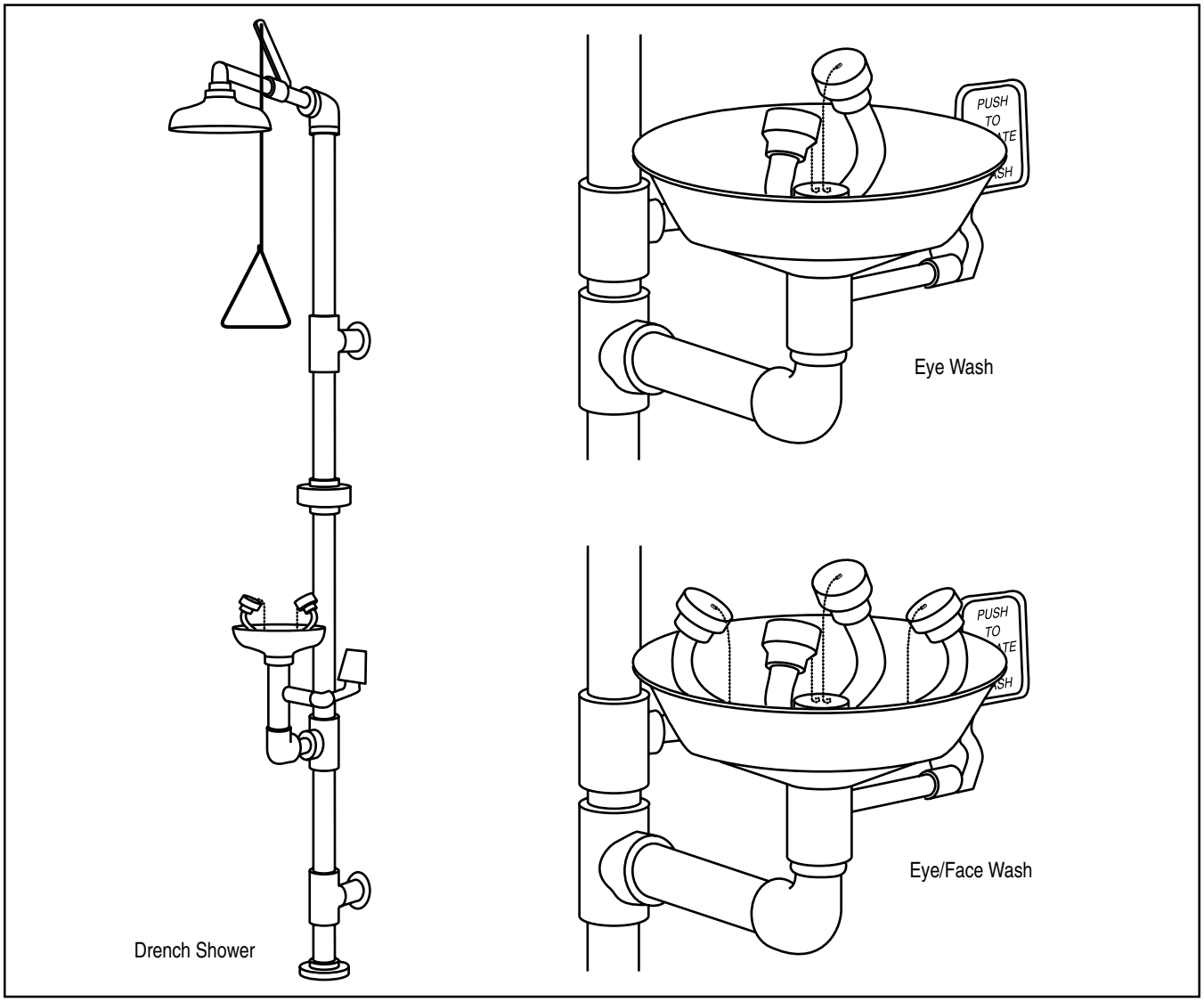


Figure 5. Drench shower and eye wash.

Design considerations for the loading pad include the following:

Size

The width and length should be large enough to hold the largest piece of application equipment. Where boom sprayers are used, the shape of the pad may be such that containment is only under the main body and the extended booms.

Base

Loading pads are usually constructed of concrete; however, portable pads made of steel, reinforced plastic, and polyethylene are available. The material must be watertight, with a surface that is impervious to chemicals. Plain concrete is not acceptable unless coated with a surface treatment. High-strength, reinforced concrete is preferred to avoid cracks. Concrete specifications are discussed later in this publication.

Liquid Holding Capacity

Capacity requirements vary from state to state, with some states having no regulations in place at this time. Requirements for pad volume range from 110% – 125% of the volume of the largest sprayer tank to a fixed volume such as 1,000 – 1,800 gallons. Secondary volume, the capacity of the rinsate tank storage, is usually 110% of the largest sprayer tank volume plus six inches of rain if the pad area is not covered. A roof over the pad should be considered in the Eastern United States.

The storage volume of the pad can be increased by increasing the curb height. Secondary volume can be increased by installing more tanks. The pad and sump must be able to hold a worst-case spill. Rinsate storage tanks should be high density polyethylene (HDPE) or stainless steel.

To determine the volume of rain captured by the pad, use the following equation:

Volume of rain (gallons) =
0.62 x inches of rain x pad length (feet) x pad width (feet)

To calculate the storage volume of the pad, use the following equation:

Pad volume (gallons) =
0.62 x curb height (inches) x pad length (feet) x pad width (feet)

Sump Location

The purpose of the sump is to collect the spilled material and facilitate its transfer to the storage tanks. The pad should be sloped so that all material flows toward the sump (figure 6, page 6). For concrete pads, a slope of 2% is desirable. Other materials can use less of a slope if the surface is smooth. For a pad that slopes from one side to the other, a corner sump can be used. If the pad is sloped from the sides to the middle, a trench is used to carry the liquid to a rear sump.

Sump Design

Sumps should be made as shallow and as small as practical. State regulations often designate maximum allowable sump volumes. Small sumps ensure efficient liquid transfer and eliminate trash buildup. Sumps can be cast-in-place concrete, prefabricated concrete, stainless steel, or plastic. Watertightness is important, as is the seal between the pad and the sump. Cover the sump with a structural grate for safety. A dust cover will prevent dust and debris from falling into the sump when it is not in use. Sand/mud traps (figure 7, page 7) need to be cleaned after each use and the sediment disposed of safely.

Sump Pump

The pump should be large enough to transfer the liquid from the sump to the holding tank at the fastest sump filling rate expected. The gallon-per-minute rate should be equal to or greater than the rate of the sprayer pump, wash-down pump, or a three-inch-per-hour rainfall on the pad. Transfer-pipe size should be matched to pump capacity. To convert three inches per hour to gallons per minute, use the following equation:

Gallons per minute =
[3 inches/hour] x [pad length (feet)] x [pad width (feet)] ÷ 96.3

All parts of the plumbing system, including the pump, piping, valves, and fittings should be corrosion-resistant. Stainless steel, polypropylene, and Kevlar™ are acceptable materials. Seals should be selected for their resistance to the solvents and surfactants that are common in pesticides. Hoses must also be compatible with the chemicals being used. The high initial cost of corrosion-resistant materials is offset by lower maintenance costs. Exterior storage tanks not enclosed by a fence should be fitted with lockable shutoff valves for security.

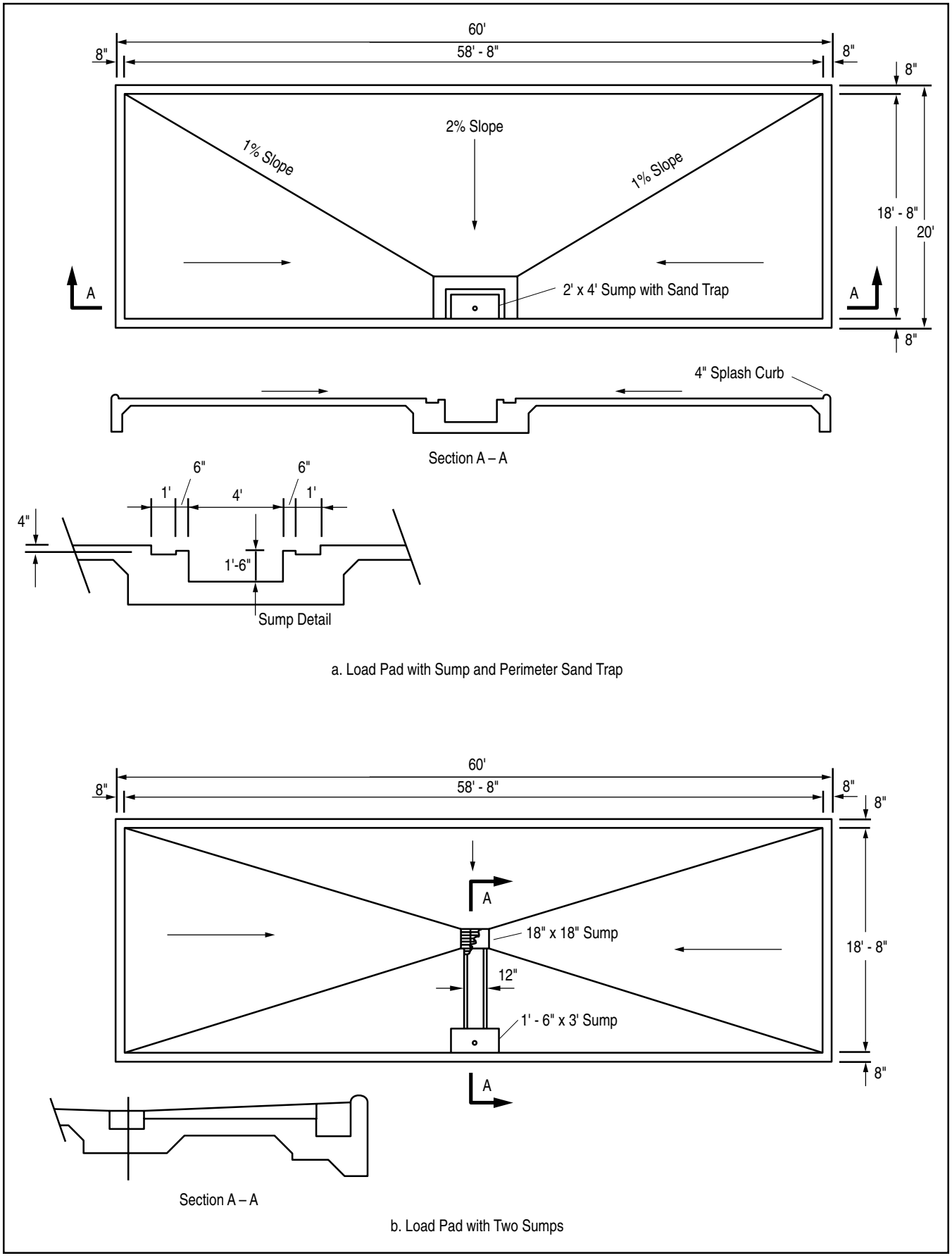


Figure 6. Slope of pad to sump.

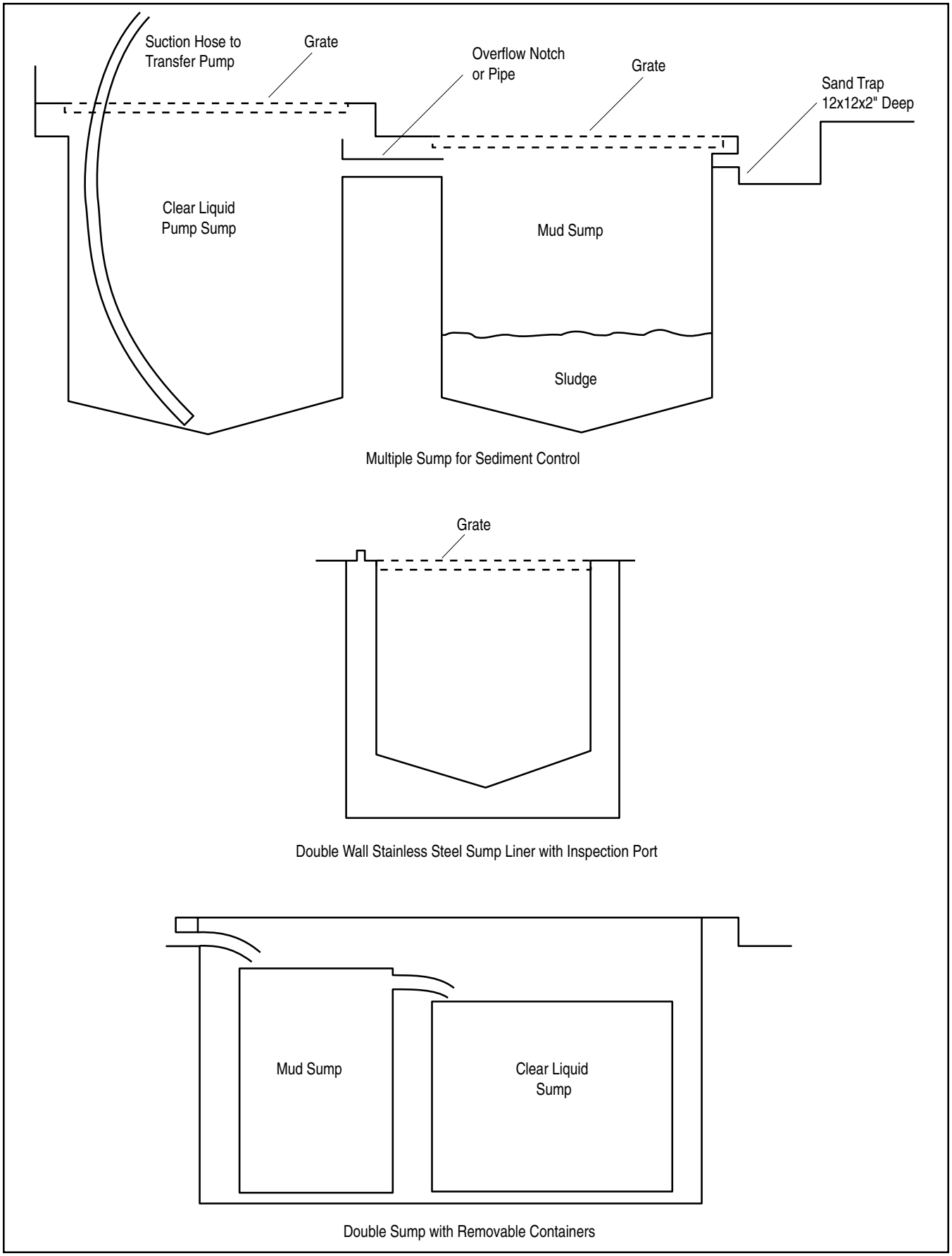


Figure 7. Multiple sumps to trap sand and mud.

Adapted with permission from Designing Facilities for Pesticide and Fertilizer Containment, *MWPS–37, revised first edition, 1995. © MidWest Plan Service, Ames, Iowa 50011-3080.*

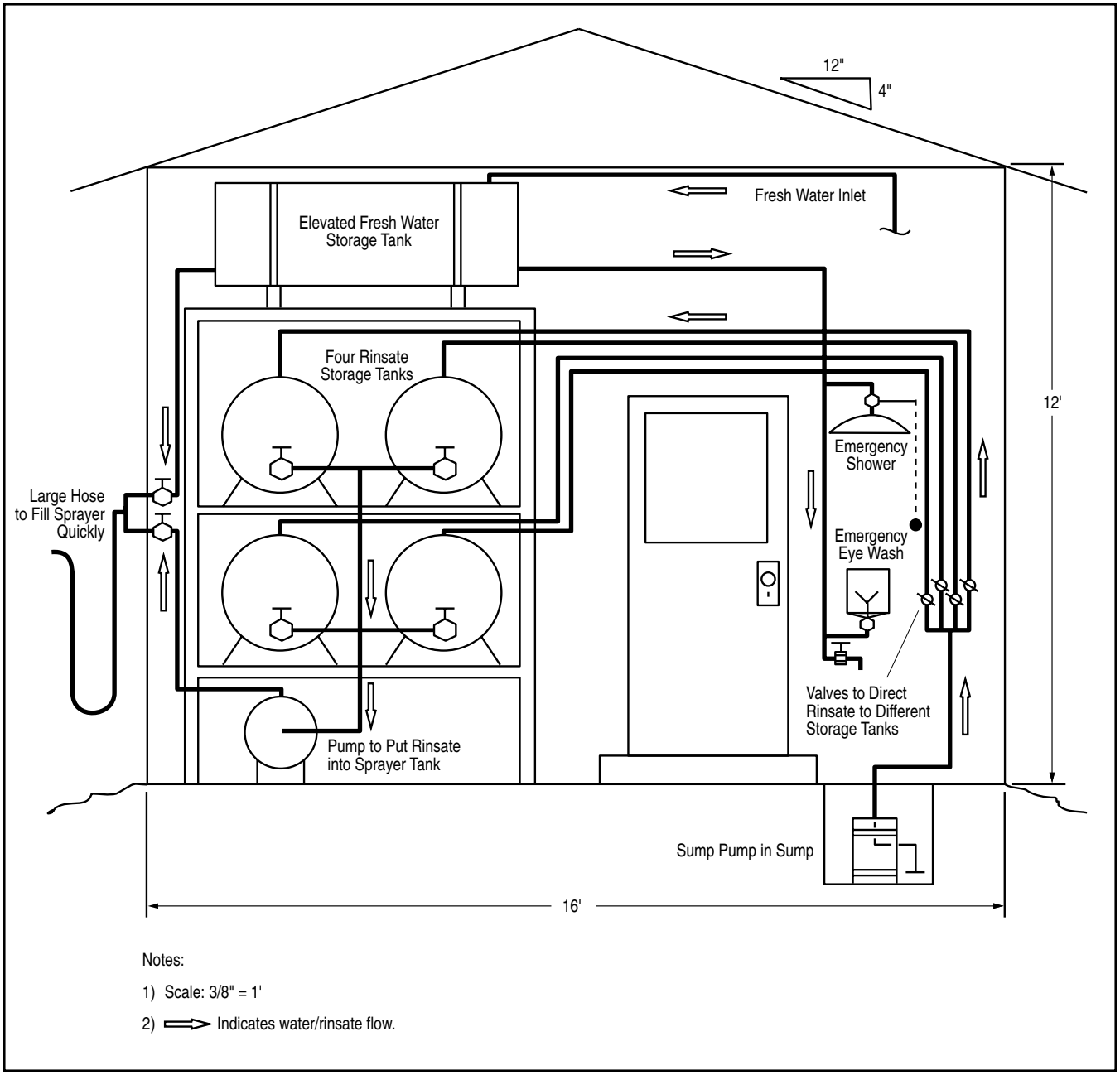


Figure 8. System to store rinsate and supply fresh water.

Figure 8 shows the plumbing system for directing rinsate water into separate tanks and for handling fresh water for tank filling and emergency wash purposes. All tanks are elevated on a heavy steel support frame so the floor can be cleaned easily. Allow a three-foot clearance for easy inspection. Fresh water in an elevated tank provides a large flow rate for fast filling of tanks and for emergency eye wash and drench shower equipment.

To reduce the volume of rainwater collected on the pad that subsequently has to be stored, a shelter over the pad is desirable. A pole building with open sides works well. A low-cost alternative is a greenhouse frame covered with a three-year copolymer film (figure 9). Greenhouse frames are available in widths up to 40 feet.

Portable Containment Pads

Several companies market portable or temporary containment pads. There are two types available: vinyl- or nylon-reinforced elastomer pad with an inflated berm and steel. Sizes vary from 4 x 8 feet to 34 x 74 feet.

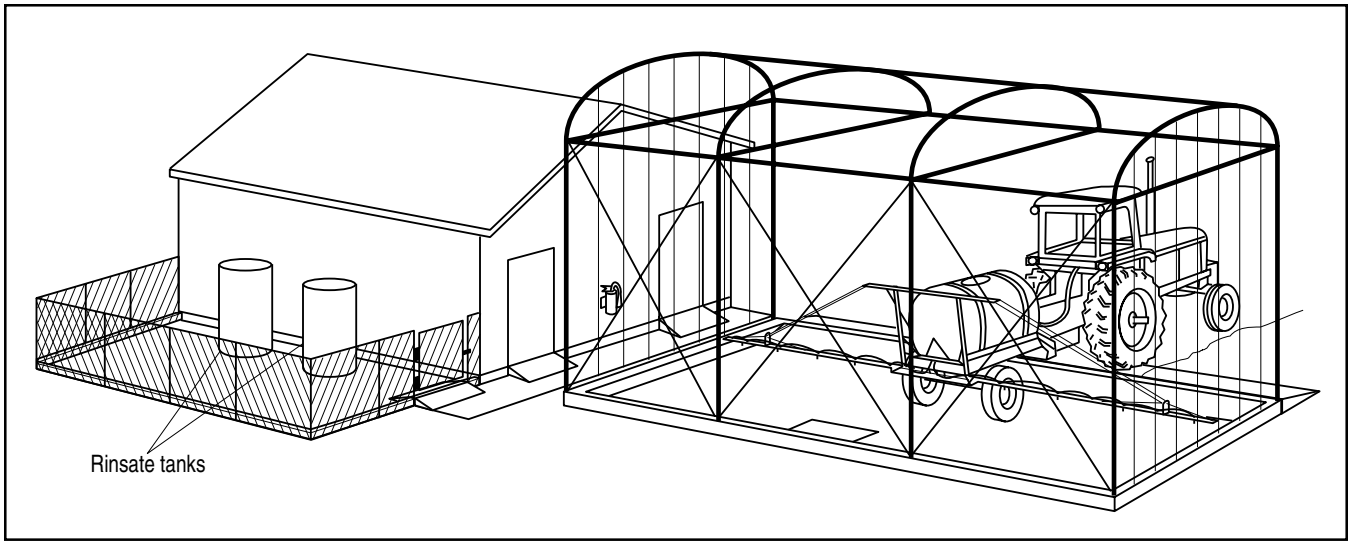


Figure 9. Greenhouse frame to keep rain off loading pad.

The elastomer pads are the most common type (figure 10). The pad is rolled over a level surface that does not have rocks that will puncture the pad when the sprayer is driven over it. A sand bed is recommended. The sprayer is driven over the berm onto the pad. The spray material is loaded, and the sprayer is driven off. Any spillage is collected with a squeegee and removed with a sponge, mop, or sump pump. Ideally, the material collected will go back into the tank for later use.

Steel portable containment pads are treated to be corrosion-resistant and are modular. Sections can be put together to result in the size required. The equipment is driven up a ramp to get on top of the heavy steel floor grating above a containment tank. This type usually has a three-inch sump drain threaded or flanged. Options such as pumps and portable storage tanks are available to provide a complete handling system.

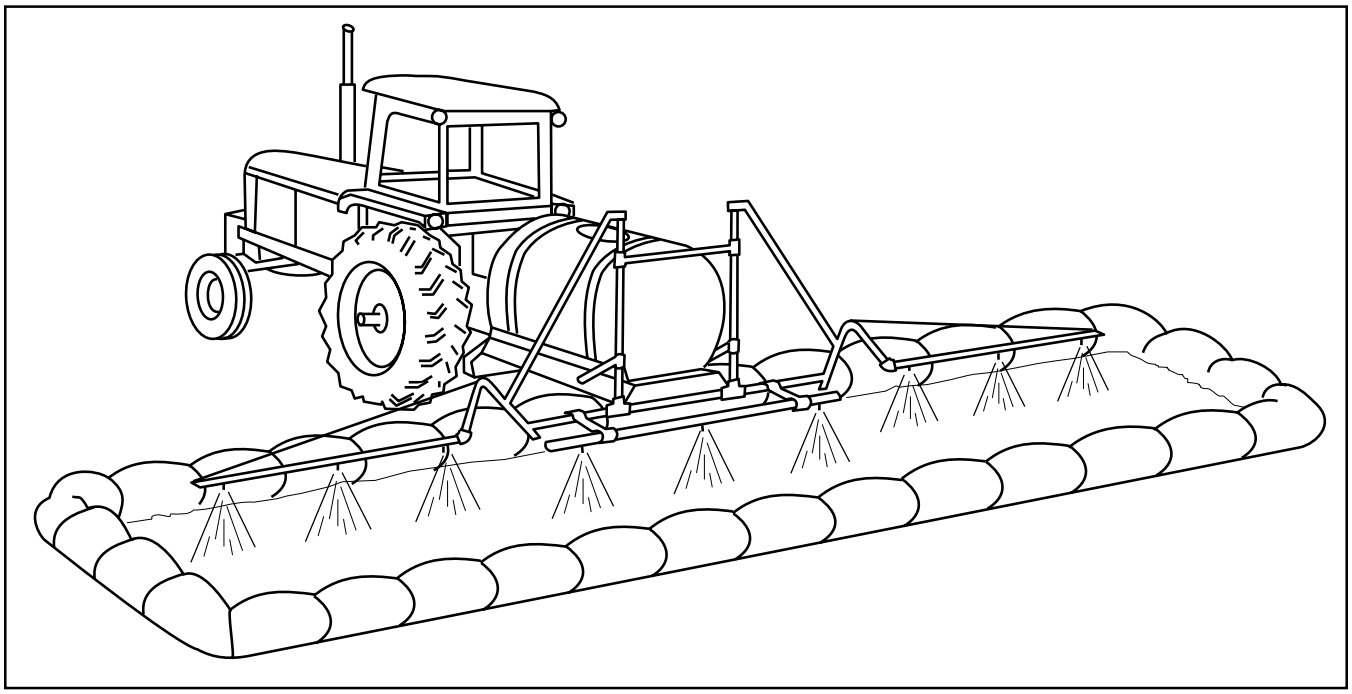


Figure 10. Portable containment pad.

Storage Environmental Requirements

The following environmental requirements should be considered when designing or building a pesticide storage.

Light and Temperature

Exposure to sunlight may cause chemical breakdown, reducing the effectiveness of the pesticide. Therefore, pesticide containers (especially glass and aerosols) should never be placed in front of windows. Be sure to provide adequate lighting in all parts of the storage so that chemical labels can be read easily and people can work safely.

High temperatures can cause liquid pesticides to expand, causing increased pressure within the container. Under these conditions, the pesticide may leak from the container, or an explosion could occur. Freezing temperatures should also be avoided. Some pesticides separate or break down chemically at lower temperatures; and containers may crack, as well.

Store pesticides at temperatures above 40°F and below 100°F. Follow the label directions for more specific requirements. Flammable (Class I) and combustible (Class II or III) liquids have special requirements for storage. Refer to National Fire Protection Association (NFPA) codes for more details.

Humidity

Locate the storage away from high-humidity areas or provide dehumidification. Excess moisture may cause caking or degradation of dry formulations, making them impossible to mix thoroughly or destroying their effectiveness. Metal containers will eventually rust and may develop leaks. The strength of paper bags may be reduced, causing spillage.

Contamination

Within the storage, the different groups of pesticides (herbicide, insecticide, fungicide, rodenticide, and so on) should be kept separate to prevent cross-contamination. In small storages this may be done by providing separate shelves. Where large quantities of materials are stored, a separate room for herbicides is desirable.

Special precautions must be taken when storing herbicides (weed killers), especially when containers have been opened and reclosed. The phenoxy herbicides, such as 2,4-D, are among the most volatile; and their fumes can temporarily contaminate soils, fertilizers, growing containers, and so on, thus injuring plants. Volatile fumes can build up in a closed area and follow air currents, so a well-designed ventilation system is required.

Metal shelves are preferable to wooden shelves for storing pesticides because they are much easier to decontaminate. Leakproof plastic trays work well to hold bottles and bags, as they will contain any spillage. Drums should be stored off the ground on spill containment pallets (see figure 2, page 2). The containment volume should be large enough to hold 125% of the largest drum. Shelves, pallets, and drums should be placed along the walls of the storage to keep the aisle clear. A three-foot clearance between the walls and pallets and drums is necessary for inspection.

Ventilation

Good ventilation removes excess heat, chemical vapors, and moisture from the facility and is very important for safety. Ventilation can be by natural and/or mechanical means. Two levels of ventilation are needed. A low, continuous rate in the storage room helps prevent a buildup of toxic fumes. An additional fan system should be engaged just before workers enter the storage and while they are in the storage. The mixing room and the records/locker room should be ventilated before and during occupation. At mixing tables, where toxic dust or fumes originate, special fume or dust hoods will move dust and fumes away from the worker (figure 11).

During cold weather, ventilation may be reduced or blocked off so heat can be added to maintain 40°F in the storage room. The additional fan system must be used to clear out toxic fumes before entering the room.

Natural ventilation may be used, particularly in unheated spaces, to remove fumes and heat when the space is closed up. Put at least two vents, each 8 x 8 inches in size or larger, on opposite sides of the building and within 12 inches of the floor. Provide one square foot of "free open vent area" per

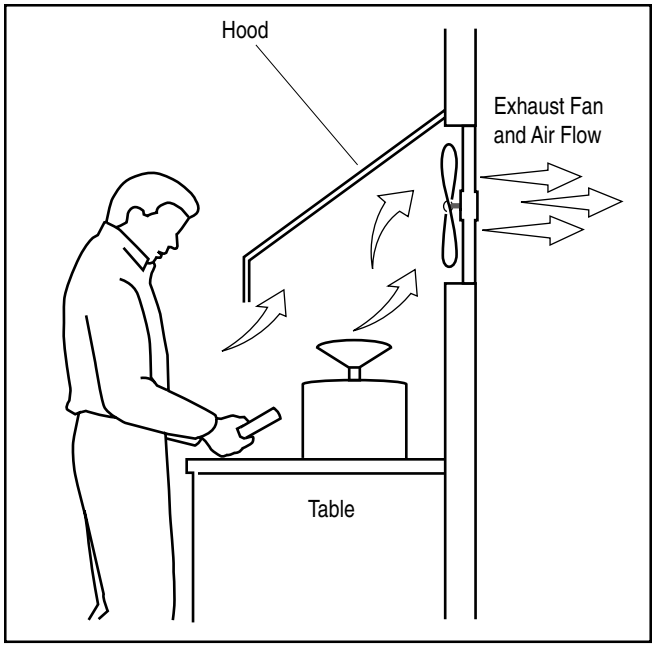


Figure 11. Fume hood over table to remove dust and fumes.

20 square feet of floor area. "Free open vent area" is the total vent area minus the area of obstructions such as louvers. Heavy, possibly flammable, fumes concentrate near the floor. Vents within 12 inches of the floor help dissipate these fumes. Eave and ridge vents should be installed to remove excess heat.

Mechanical ventilation provides the most control. Locate a small exhaust fan on the east or south side of the room with an air inlet louver on the west and north side to take advantage of natural air movement. A small, continuously-operated exhaust fan in the storage room should provide a minimum of one air change per *hour.* Ventilation fans are specified in terms of the cubic feet of air they can move in a minute (cfm). To determine the volume of a space in cubic feet, measure the length, width, and height in feet, then multiply L x W x H. Convert cubic feet per hour to cubic feet per minute by dividing by 60. Select the fan to provide the required air flow at 0.125-inch water static pressure. Air flow rates at different static pressures are usually listed in the fan specifications.

Exhaust fans are usually mounted high on the sidewall of the building or cabinet. To remove the heavier fumes during continuous ventilation, build a duct from the fan down to within 12 inches of the floor to draw out the fumes. Place the air inlet on the opposite wall within 12 inches of the floor. Let the fan run continuously.

When the space is occupied, provide a ventilation rate of at least 6 air changes per hour ($^1/_{10}$ air change per minute) or at least one cfm per square foot of floor area with 150 cfm as a minimum. This second rate is a National Fire Protection Association (NFPA) recommendation for the ventilation of mixing and handling areas. Table 1 gives values for different space sizes.

Table 1. Mechanical ventilation rates and inlet sizes for occupied spaces.

	Six Air Changes/Hour		NFPA Recommendation	
Building Volume[a]	Rate	Inlet Size	Rate of 1 cfm/square foot	
cubic feet	cfm	square inches	cfm	square inches
1,000	150[b]	30	150[b]	30
2,000	200[c]	40	250	50
3,000	300	60	375	75
4,000	400	80	500	100
5,000	500	100	625	125
6,000	600	120	750	150
7,000	700	140	875	175
8,000	800	160	1,000	200
9,000	900	180	1,125	225
10,000	1,000	200	1,250	250

[a] Assumes a ceiling height of 8 feet.
[b] National Fire Protection Association (NFPA) recommends a minimum of 150 cfm.
[c] To obtain six air changes per hour for a 2,000-cubic foot room, the fan system must deliver 12,000 cubic feet per hour or 200 cfm.

The ventilation system used when workers are in the room and the interior lights should be controlled by a common ON/OFF switch located outside the building. Putting the lights and fans on the same switch helps to ensure that the fans are used. The storage and mixing rooms should be ventilated separately where possible. Use a switch with a built-in indicator light or use a light mounted on the side of the building to indicate that the ventilation system is on. This provides a safety factor in that it signifies that someone may be in the room.

Air inlets are necessary to admit makeup air and should be located on the opposite side of the room from exhaust fans. They should be sized to provide 20 square inches of free open area per 100 cfm of fan capacity. The required inlet louver free open area is calculated as follows:

$$\text{Inlet free open area (sq in)} = \frac{\text{ventilation rate (cfm)} \times 20 \text{ sq in}}{100 \text{ cfm}}$$

Inlet vents will generally have the free open area marked on them; or, if not, it should be available from the manufacturer. Inlet vents with motorized louvers are suggested. The louvered vent is usually slightly larger than the exhaust fan.

Exhaust hoods over the work area in the mixing room provide added worker protection. A fresh-air velocity of 80 to 100 fpm at face level pulls dust and fumes into the hood and away from the worker (figure 11, page 11).

Safety Requirements

While all aspects of the facility are directed toward safety, some specific safety requirements are as follows.

Signs

Storage doors and windows should be kept locked at all times. Weatherproof signs, stating "Danger – Pesticides – Keep Out!" or a similar warning should be posted on each door of the facility and over all windows (figure 12). In some cases, it may be advisable to post the signs in more than one language. "No Smoking" signs should be placed both outside and inside the facility. "EXIT" signs should be on all exits.

Figure 12. Sign to warn people.

Fire Safety

An emergency plan should be developed for the storage and should include response, actions, responsibilities, and training. If an incident occurs, the plan can reduce liability through the timely actions of knowledgeable responders.

The storage should be protected by strategically located fire, smoke, temperature, and power sensors. If possible, connect these to an existing alarm

system. Where the office and residence are located nearby, the alarm system can be hard wired. Remote facilities can be connected to the office or residence by phone line with a dialer. For large facilities, it is desirable to include the fire department in the notification of an emergency situation.

Within the storage, a ten-pound ABC-type Halon fire extinguisher should be located near each exit. Automatic dry chemical extinguishing equipment is desirable for large facilities.

An emergency response plan will minimize the risk of injury or environmental contamination in the event of a fire or spill. Copies of the emergency response plan should be given to the local fire department and police. Key employees should keep a copy of the plan off-site or in their vehicles. An emergency response plan should include the following:

- Street location of the property including a map with directions to the agrichemical facility.
- Names, addresses, and telephone numbers of the owner and key employees.
- Sketch of the storage facility and immediate surroundings showing location of pesticides; flammables; electrical service; water supply; fuel storage tanks; distance to nearby buildings, fences, and gates; fire hydrants; storm drains; and nearby wetlands, ponds, or streams. Indicate the direction of runoff water and how this might be blocked.
- Agency notification listing with names and telephone numbers of fire, police, hospital, environmental protection agency, and spill-cleanup firms.
- Location of emergency equipment and supplies including self-contained breathing equipment, protective clothing, portable water pumps, sand bags, spill cleanup materials, and earth-moving equipment.
- Location and types of water supplies such as hydrants, ponds, and wells. Hydrant thread compatibility, water pressure, and flow rates should be checked by the local fire department.
- Attach MSDSs for all stored products with health hazards and safety instructions highlighted. Provide a list of chemicals including quantities and location. This list should be kept updated.

In the planning stage, an agreement needs to be developed among the owner, fire department, environmental protection agency, and insurance company about what action will be taken if a fire starts. One such agreement associated with a separate storage building reads as follows:

> *Should this facility become involved in fire, the commanding fire officer at the scene should let the facility burn if he determines that continued water application: 1) will result in extensive contaminated water runoff or 2) could result in incomplete combustion of chemicals, resulting in a release of toxic compounds into the air.*

The best emergency response to a fire will depend on the chemicals being stored.

Personal Emergency Equipment

For the protection of workers, the mixing and/or pad area should have the following equipment:

1. First aid kit that includes adhesive strips, tape, ammonia inhalants, eye pads, burn cream, gauze bandages, scissors, and tweezers.
2. Eye wash connected to a water supply. Portable eye wash stations are also available that have self-contained water supplies or that use a buffered solution.
3. A drench shower is highly desirable because it provides a large quantity of water that quickly washes away the chemicals spilled on workers. At a minimum, a hose and nozzle should be handy and ready at all times. The shower is best if vision is obscured.

Pesticide Spill Kit

In the handling and mixing of pesticides, spills are apt to occur. Quick response is needed to prevent the pesticide from spreading. The following materials should be readily available in the mixing area:

- Drain blocker—plastic or rubber mat or plug to cover a floor drain. (Floor drains that penetrate the floor are not desirable in new construction.)
- Absorbent mats, pillows, or socks.
- Granular absorbent, such as peat moss, clay, or kitty litter.
- Hydrated lime in a covered plastic pail.
- Sodium hypochlorite (laundry bleach)—one or two gallons.
- Broom; small, flat shovel; and squeegee.

- Plastic pails, drums, and heavy-duty plastic bags to hold waste material.
- Drum repair kit to stop leaks.
- Barricade tape to restrict access to the area.
- A source of clean water. An elevated clean water storage tank is suggested where the water supply is limited.

Personal Protective Equipment Storage

Items of protective clothing and protective equipment should be stored nearby (but not inside) the pesticide storage area. Provide each person with two lockers, one for street clothes and the other for work clothes to prevent cross contamination. If a separate office is not maintained, the storage records, including application data and MSDSs, can be stored in a file in this area.

Storage Alternatives

Storage inside Existing Buildings

Three methods are used for chemical storage in a building: a storage cabinet, a storage locker, or a room within a building. The chosen method should be large enough to hold the quantity of pesticides to be stored with additional space for access or expansion.

Storage Cabinet

One or more steel cabinets work well for storing the quantities used in small operations or by part-time farmers (figure 13). These are available in many sizes as wall-mounted, under-bench, or

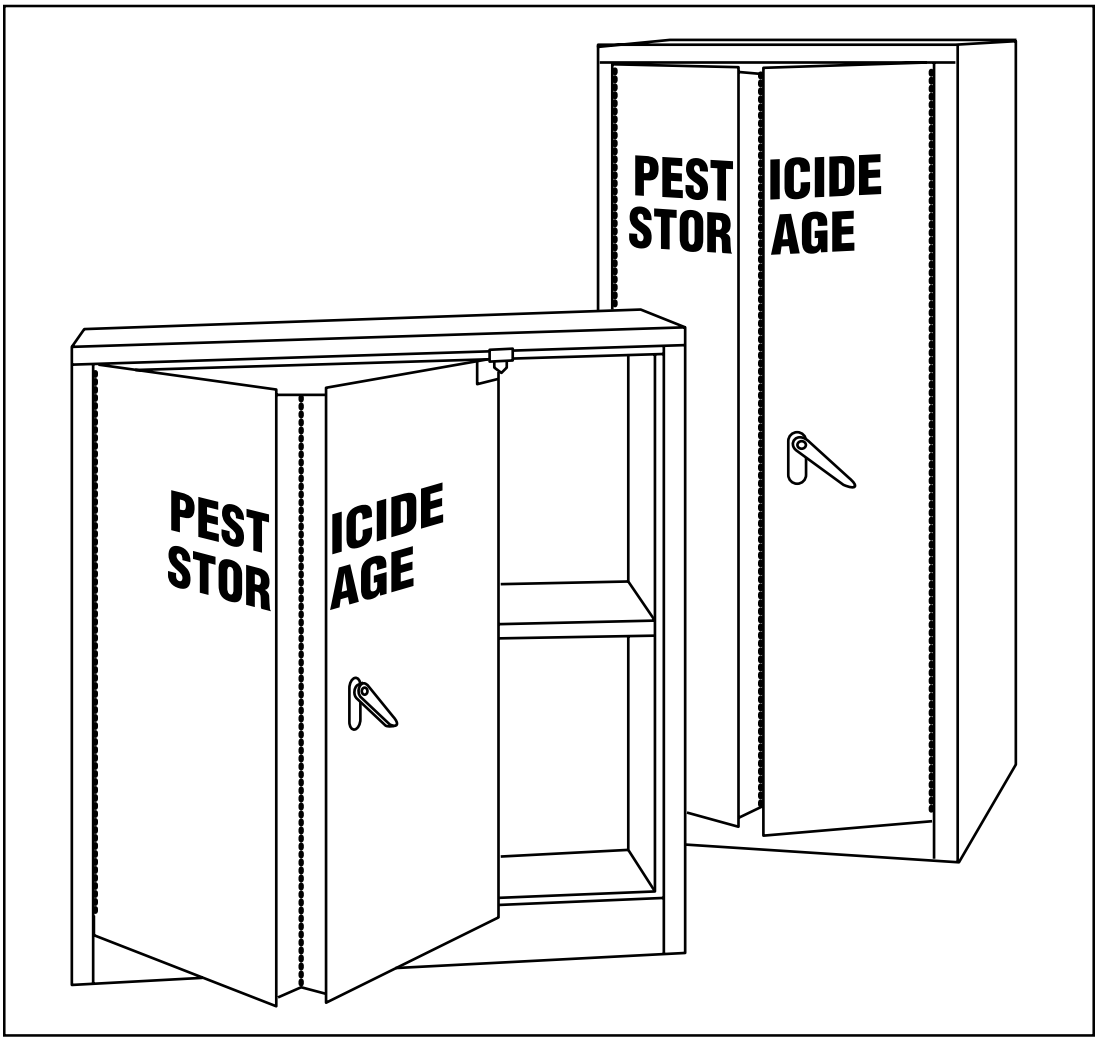


Figure 13. Small storage cabinets.

freestanding units. They can be fire rated or non-fire rated. Before purchasing, review MSDSs to determine if the pesticides to be stored are flammable. If so, a fire-rated cabinet is needed and should meet OSHA and NFPA Code 30 specifications. The cabinet should also have vents, a lock, and a spill containment area in the bottom.

Locate the cabinet along an outside wall in an area away from extreme heat and freezing temperatures and near the mixing area. Pesticides should be separated by type and stored on shelves in plastic, leakproof trays. It is desirable to store herbicides in a separate cabinet from other pesticides.

Storage Locker

Steel storage lockers are available in sizes from 4 x 6-foot floor area (figure 14, page 16). They are prefabricated by the manufacturer and shipped completely assembled. They are waterproof and designed with adequate snow and wind loading to be used outside or inside. The locker is moved with a fork lift. Secondary containment is provided in the base. Chemical-resistant coatings are used for corrosion protection. Vents for natural air movement are standard, but fan ventilation and auxiliary heat can be added for better environment control. Optional features include metal shelving, interior lighting, and a loading ramp for easy access.

If pesticides rated "flammable" are to be stored, a UL-rated or Factory Mutual System-approved locker should be purchased. This will contain vents with fire dampers and fire-rated walls, ceiling, sump, and doors. Any electrical system must have explosion-proof boxes and fixtures.

An example of 1995 costs for a 6'-6" wide x 8' long x 8'-4" high locker is about $3,500 for a nonrated structure and $5,000 for a fire-rated one. A charge for delivery may be added.

Room within a Building

A storage room constructed within a building should be located adjacent to an outside wall and away from the office, utility room, and lunch room (figure 15, page 17). Windows, if any, should be covered to eliminate sunlight. A separate area near the storage is desirable for weighing and mixing pesticides. It should contain a sink and counter space. A door to the outside or, in a large storage, an overhead door for fork lift access is desirable.

Walls can be constructed of 2 x 4 lumber. Insulation should be added if the building is unheated to guard against freezing temperatures. Use R-11 fiberglass insulation or equivalent in the walls and R-19 (six inches) fiberglass in the ceiling. A continuous 6-mil polyethylene vapor barrier should be placed between the wall and ceiling surfaces and the studs. The wall surface can be exterior plywood finished with a chemical-resistant paint such as polyester or epoxy. Alternate surfaces are a high-density overlay plywood that does not require painting or a $1/8$ to $5/32$-inch high-density polyethylene board joined with extruded moldings.

Some surface treatment is needed for the concrete floor as it is quite porous to some types of pesticides. Preliminary testing of surface treatments at the National Fertilizer and Environmental Research Center, Tennessee Valley Authority, Muscle Shoals, Alabama shows that Vinyl Ester Resin and Epoxy Novolac Resin had good resistance to chemical action and good mechanical properties. These should be applied to manufacturers' recommendations. A new floor surface may be required. Further testing is underway, and other materials may prove acceptable.

If flammable pesticides are to be stored, explosion-proof lighting equipment and motors are needed. A dry-chemical fire-suppression system could also be installed for safety and lower insurance costs.

If heat is needed, an electric heater sized to provide a minimum temperature of 40°F on the coldest night can be used.

Volatile fumes escaping from pesticide containers can build up in a storage area; therefore, ventilation is necessary. A continuously-operating, two-speed exhaust fan located on an outside wall should be sized to provide one volume air change every ten minutes at high speed. The minimum high-speed ventilation rate is 150 cubic feet per minute (cfm). The high speed on the fan motor should be connected to the room light switch. When the room is not occupied, the fan speed should be switched to low speed and provide one volume air change each hour. Two separate fans can better match the requirement; a small, continuously running fan will lower operating costs.

Volume in cubic feet is calculated by multiplying length x width x height. For example, a room having the dimensions 10' x 12' x 8' contains 960 cubic

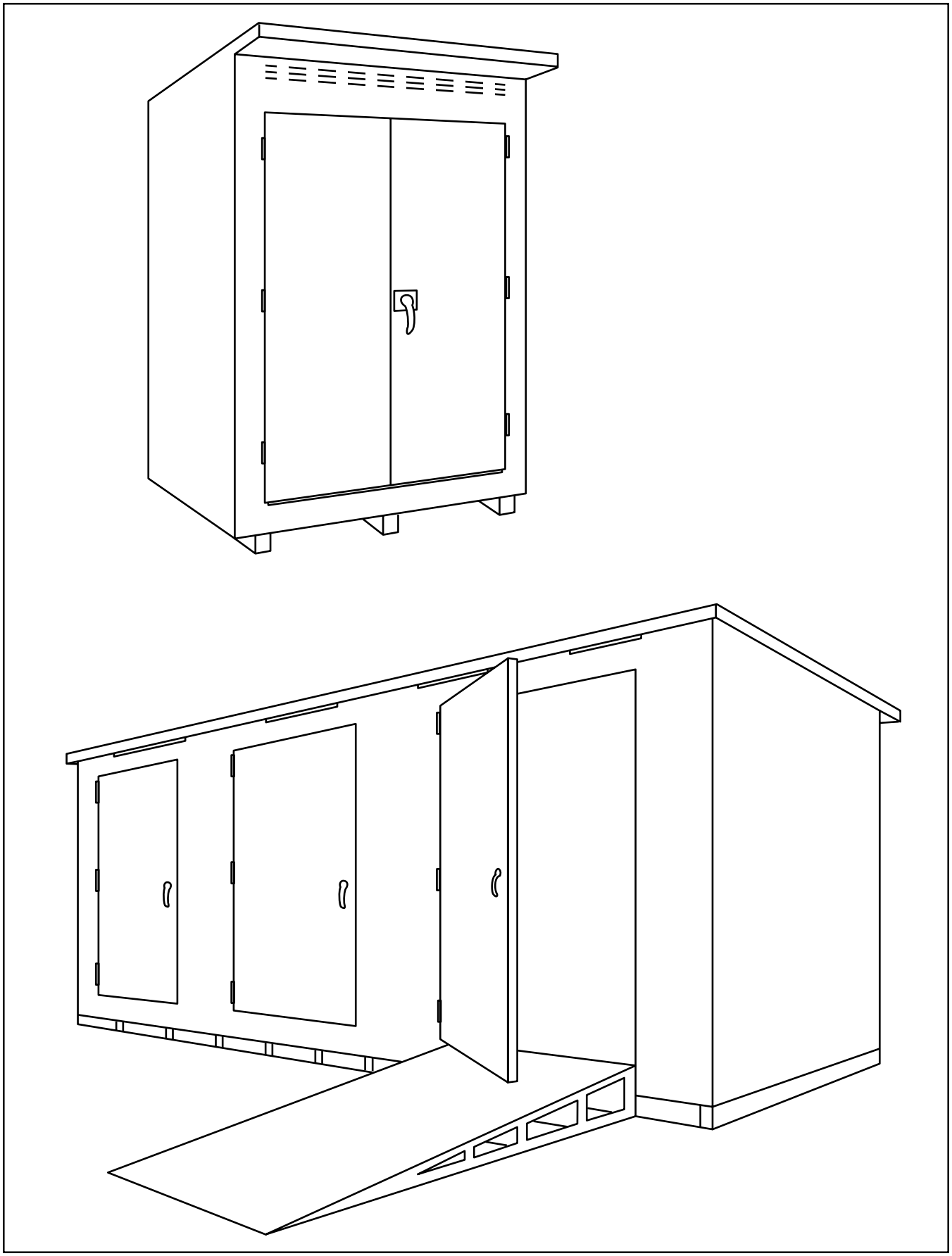


Figure 14. Steel storage locker – 4 x 6 feet or larger.

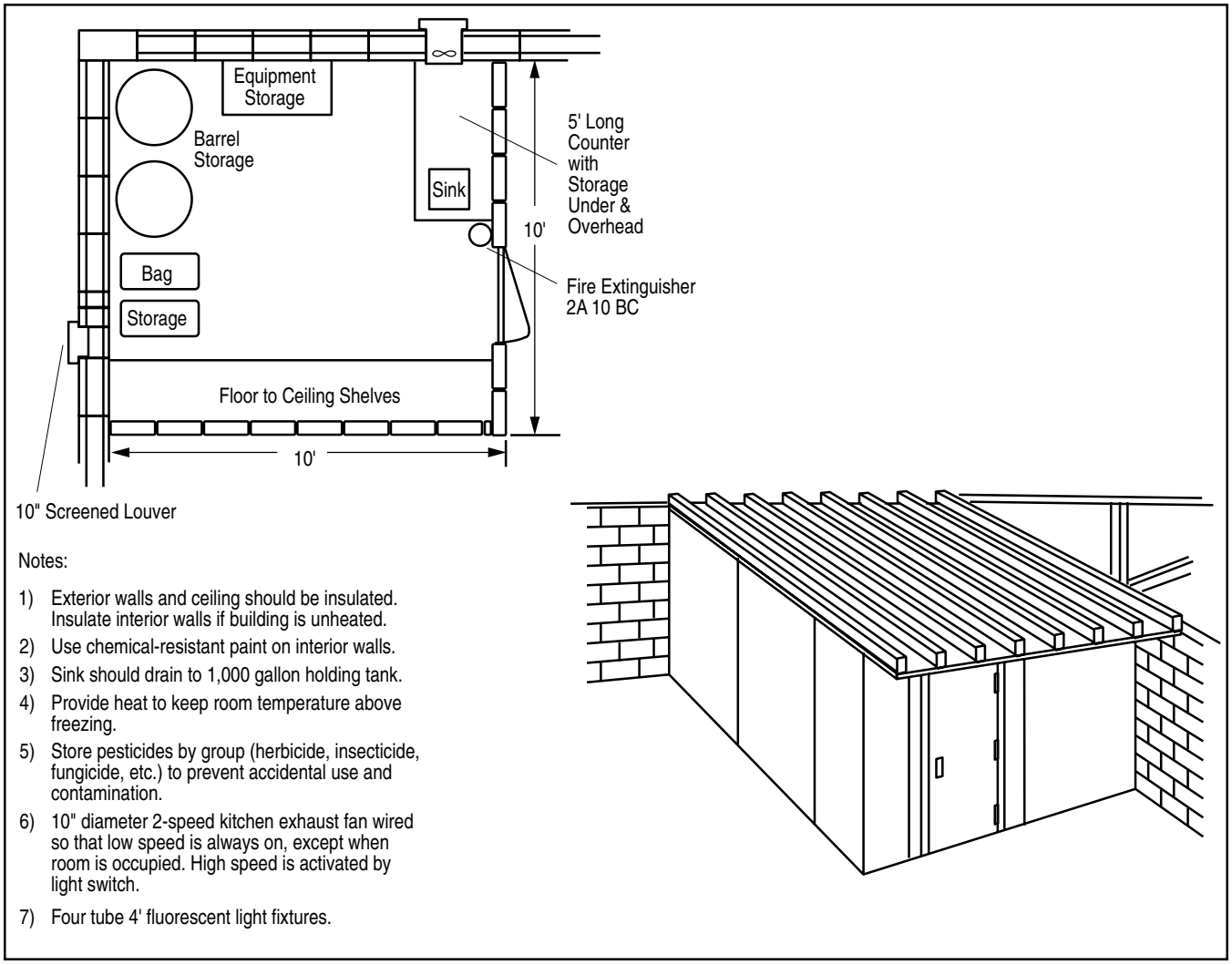


Figure 15. Storage room built inside a building.

feet. As this volume needs to be exchanged every ten minutes at high speed, a fan capacity of 960/10 = 96 cfm is needed. The minimum low-speed fan rate is 960/60 = 16 cfm. The fan should be rated at 0.125-inch water static pressure (wsp) to overcome the louver resistance. The makeup air louver should be one size larger than the fan diameter and should be located in an opposite wall, preferably connected to bring in outside air rather than air from the adjacent room area.

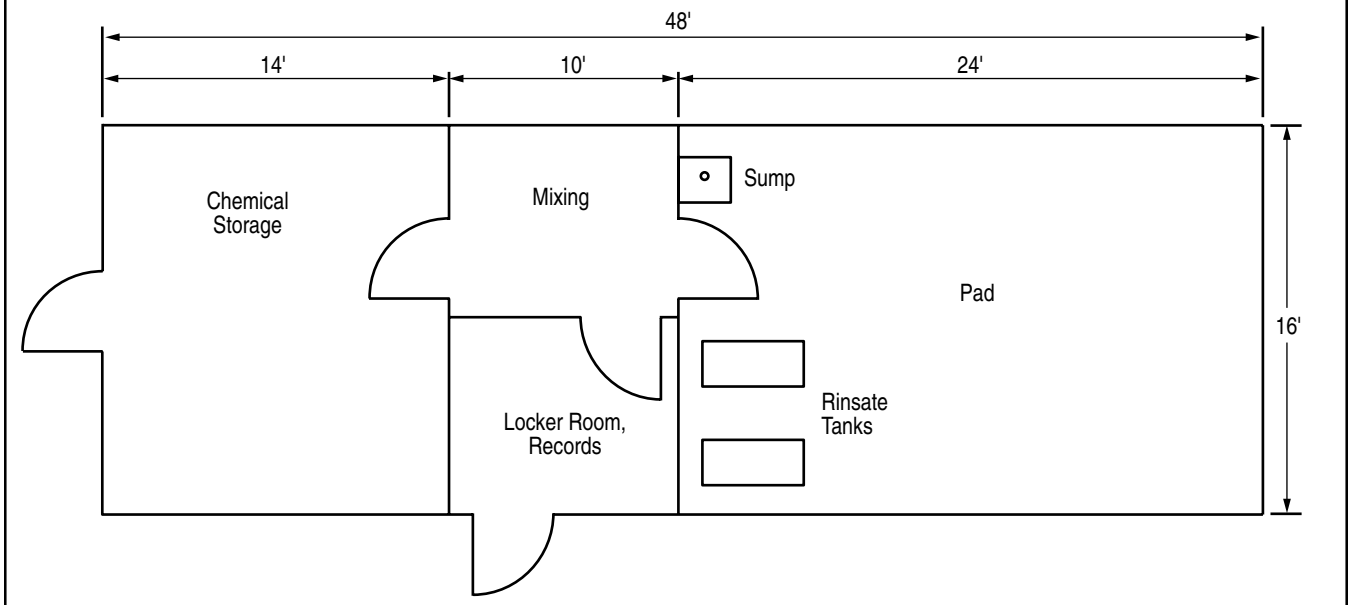
Separate Storage Building

When constructing an agrichemical storage building, it is wise to select a location away from existing buildings. State and federal agencies are currently developing regulations that may restrict building location and chemical handling procedures. Evaluate site options carefully, particularly when replacing an existing building. Renovation costs to correct problems in an existing site may exceed the cost of new construction. Figure 16 on page 18 illustrates possible layouts for pesticide facilities.

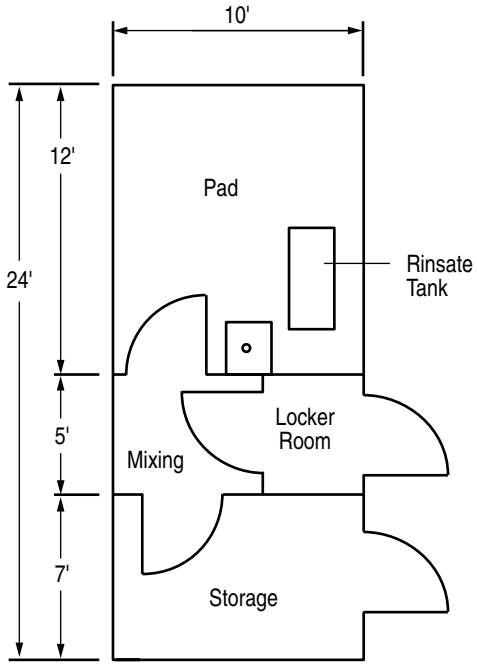
Siting Considerations

Build the pesticide storage building as a separate, isolated structure used only for pesticide storage and handling. If fertilizers are applied by the sprayer, build an adjacent but separate fertilizer storage room. Locate the building according to local zoning and wetlands agency codes. In the event that none exist, use at least a 100-foot distance from a water well, creek, pond, grass waterway, and other surface water conveyance. To avoid risk to other buildings, keep the storage building at least 50 feet from other buildings to lessen the spread of fire.

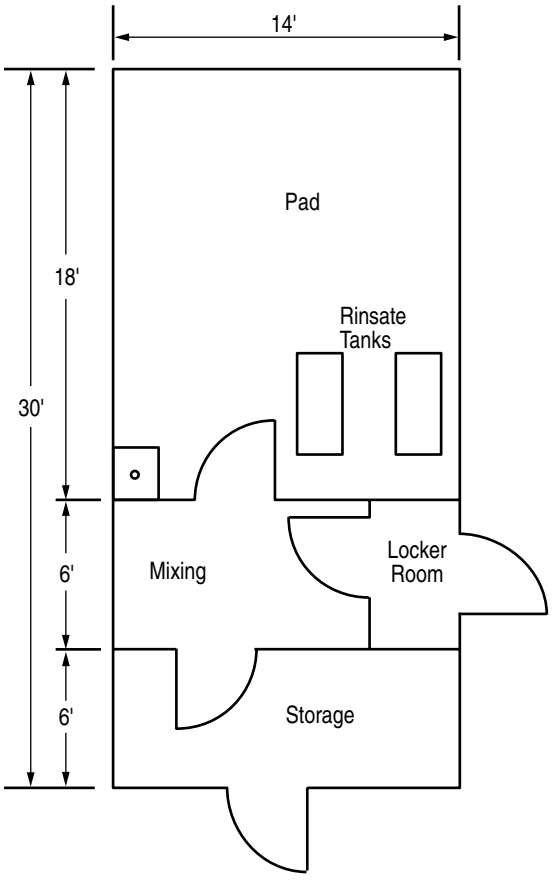
The building should sit on well-drained soil and be 12 inches above the natural ground elevation.



a. 48' x 16' Facility



b. 24' x 10' Facility



c. 30' x 14' Facility

Figure 16. Various layouts for agrichemical handling facilities.

Drain tile can be placed underground to move subsurface water away from the site, if needed. Divert all surface and clean roof water away from the concrete pad and access ramp using a dike or mountable berm (similar to a speed bump on a street). Year-round emergency and firefighting equipment access requires a solid roadbed about 12 feet wide. Surface drainage, including firefighting water, should not go toward a well or other water source.

Site Preparation and Concrete Work

Site preparation is very important because the concrete floor must remain intact. The subgrade must be graded and compacted. Drainage pipe should be installed, if needed, to keep the subgrade dry and prevent frost heaving. Build the site up above the surrounding ground. If a vapor barrier is used, cover it with a three-inch layer of compacted, self-draining granular fill. Place the concrete floor on the fill. Since the top surface of the concrete will be sealed, any moisture in or under the concrete must drain away to the ground below. Rigid-board, closed-cell insulation can be used under heated spaces and vertically around the perimeter of the foundation to reduce heat loss.

Containment is a major requirement; therefore, the floor/pad must be made of high-quality Type I or Type II cement with 5 – 7.5% air entrainment. The concrete should have 4,000 – 4,500 psi compressive strength. A water-cement ratio of 0.40 – 0.45 is used. One continuous pour should be made where possible. If separate pours are necessary, water stops should be used in the cold joints. Control joints can be placed in curbs. For spill containment within a building, a 4 – 6-inch curb is placed around the perimeter of each room and under each room partition. All floors/pads slope toward a common sump. The minimum floor/pad thickness is six inches; and the minimum reinforcement is 6 x 6-inch mesh, 6-gauge welded wire fabric. The floor should be sealed with a non-vaporizing coating to help resist reaction to pesticides and fertilizers.

A grass waterway should divert surface and roof water away from the facility. The road to and from the pad should have a surface of crushed rock (CR7), rock, or asphalt. A concrete ramp provides easy access for equipment to the pad.

Construction Details and Requirements

Building construction depends on local building codes and materials. Steel frame, post frame, stud frame, concrete, and masonry are all used. The interior walls should be impervious to pesticides and easy to clean and decontaminate. Wall liners include painted steel, aluminum, fiberglass, or high-density, reinforced plywood panels.

Exterior doors must be 36 inches wide, open outward, and have self-closing exit locks. A solid metal door with metal jamb and weather seal is recommended. Use exit doors with panic bar hardware. Panic bar hardware is the type found in public buildings with a bar across the door that is pushed to release the door latch.

Flammable pesticides have special requirements stated on the label or MSDS. Fire walls or partitions slow the spread of fire (figure 17, page 20). One $^{5}/_{8}$-inch sheet of Type X gypsum wallboard on each side of studs gives a one-hour rating. Two wallboards on each side with staggered joints give a two-hour rating. Check the pesticides being used to see if special requirements are needed in the building.

The storage room should have a 36-inch minimum aisle width, with shelves no higher than 60 inches and no wider than 18 inches. Pallets should be a few inches off the floor. Each pesticide or type of pesticide should have an individual containment tray. Each class of pesticide should be on a different shelf and, when possible, in a separate storage room or cabinet.

Water Supply

A good water supply is essential for the success of the facility. Many wells produce water at only a few gallons per minute (gpm). A well that delivers at least 5 gpm is suggested; however, the emergency shower usually operates at 30 gpm. The solution is to elevate a water storage tank above the top of the sprayer tank and use gravity flow to fill the sprayer tank and operate the emergency shower and eye wash (see figure 8, page 8). Use a large-diameter hose (1 $^{1}/_{2}$ or 2 inches) to fill the sprayer tank quickly.

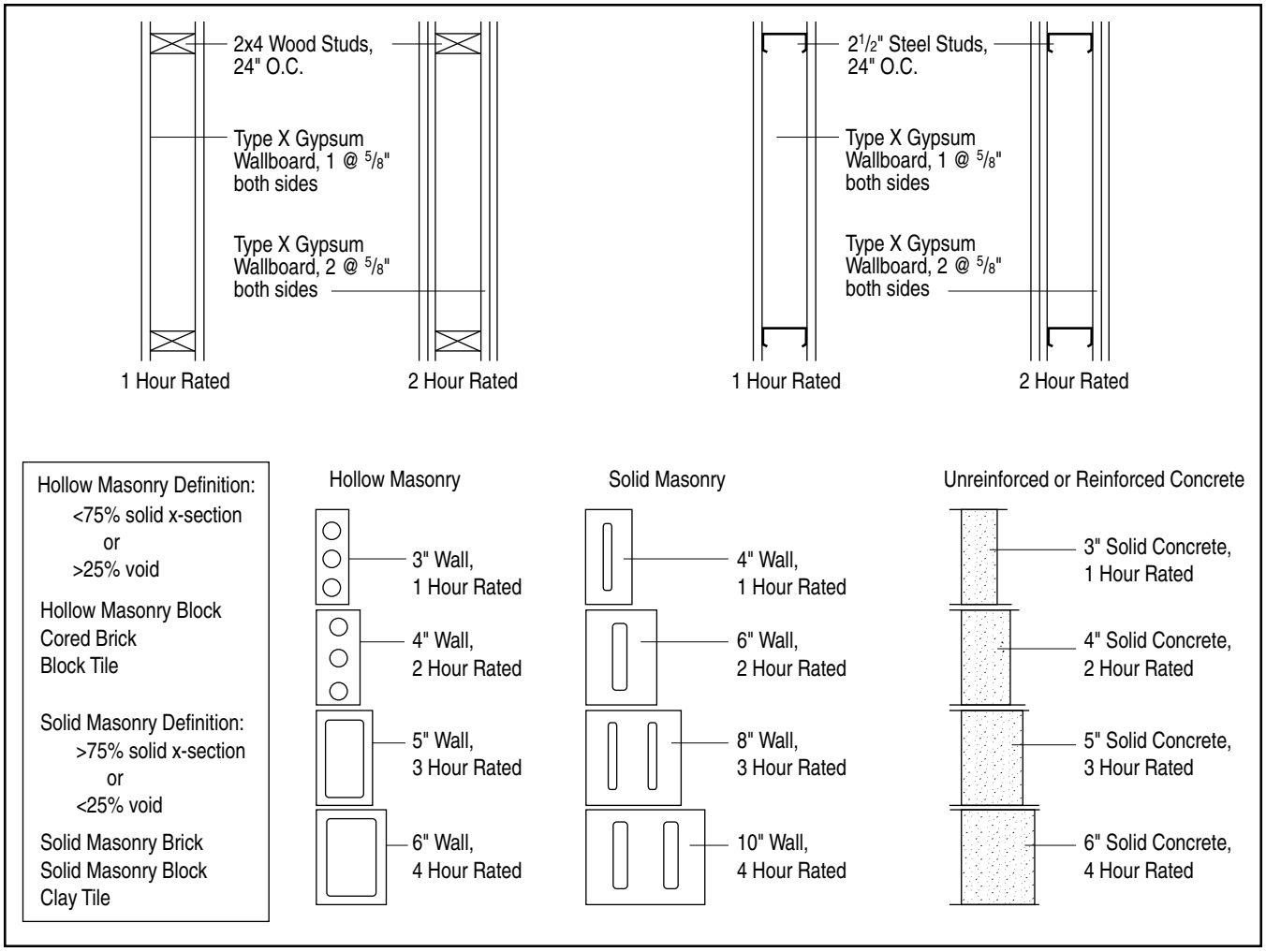


Figure 17. Fire ratings for various types and thicknesses of interior walls.

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A float switch in the water storage tank controls the pump in the well. A backflow prevention device is used where the water enters the building to prevent chemicals from flowing back into the water supply.

The water system and all storage tanks must be drained before freezing weather. Install all plumbing with proper slopes and drain plugs to ensure complete drainage. A frost hydrant might be used outside the building to prevent water in pipes from freezing. A frost hydrant has an on/off valve in the water pipe below the frost line. It includes an automatic drain to allow water above the on/off valve to drain away when the valve is in the off position.

Maintenance

Maintenance of the facility can extend its service life by many years, and its components will function much better with regular care. A plan for preventive maintenance to minimize factors that cause deterioration is important. Timely repair of small problems will prevent large problems from occurring.

Routine inspection and maintenance on a monthly, seasonal, or yearly basis for different components of the system will help to ensure proper functioning. Inspect all aspects of containment facilities, including protective coatings and paint; emergency and safety equipment; electrical systems; and pump, plumbing, and metering equipment.

Watch the exterior drainage for a few years after construction while the ground settles and the landscaping becomes established. Avoid ponding. Proper drainage helps to reduce frost heaving under the concrete structure. Keep burrowing rodents and animals away. Keep weeds under control.

Practice good housekeeping and keep the facility clean. Use a high pressure cleaner to clean the floors or pad after a spill. Wear protective gear for all

operations involving pesticides. Protect plumbing with proper design and specific procedures for draining pipes, pumps, and tanks before cold weather. Elevate pipes, tanks, and pumps at construction time so cleaning under them is easy. Rinse and drain pipes. Provide three feet of clearance around tanks for easy access to the entire tank for leak inspections.

Reduce corrosion of steel components with regular cleaning and maintenance. Washing and routine painting are two methods of protecting steel tanks, frames, grates, and pipes.

Concrete is a durable material that can resist weathering, pesticide and fertilizer attack, abrasion, and other deterioration processes. Over time, however, concrete does deteriorate due to erosion, scaling, or other processes. Erosion of concrete is caused by the abrasive action of fluid moving the concrete. Scaling occurs when the surface mortar breaks away in pieces to expose the aggregate. Areas of high traffic and areas under valves and plumbing are the most susceptible to damage. Protective coatings improve the resistance of concrete. For lasting results, an experienced applicator must prepare the surface and apply the coating.

Summary

For many situations where only a few pesticides are used, a cabinet or a room within a building can be used for storage. These spaces need to satisfy various requirements for safety, chemical containment, ventilation, and security. For larger quantities of chemicals, a separate facility may be best.

A separate area is desirable for the safe handling of pesticides. The storage area should protect agrichemicals from extremes in temperature and humidity and from unauthorized personnel. The area should include a storage room, mixing room, safety equipment and records room, and a wash down/sprayer fill pad. Secure the facility at all times. Supply electricity and water. Protective clothing is essential. Pesticides can cause severe illness and even death if handled or used improperly.

Conversion Factors

Measures of Volume (Liquid Capacity)

1 level tablespoon	= 3 level teaspoons = 0.5 fluid ounce
1 cup	= 16 level tablespoons = 8 fluid ounces = 0.5 pint
1 pint	= 16 fluid ounces = 2 cups
1 quart	= 32 fluid ounces = 2 pints
1 gallon	= 128 fluid ounces = 8 pints = 4 quarts = 231 cubic inches = 0.1337 cubic foot
1 gallon water	= 8.35 pounds
1 cubic foot water	= 62.2 pounds = 7.48 gallons

Further Reading

The references listed here were used to prepare this publication. They are available through the Natural Resource, Agriculture, and Engineering Service (NRAES); any new information will be available there also. Call before ordering.

Designing Facilities for Pesticide and Fertilizer Containment, MWPS–37, 1995, MidWest Plan Service, Iowa State University, Ames, Iowa, 124 pages.

Conference Proceedings, National Symposium on Pesticide and Fertilizer Containment: Design and Management, MWPS–C1, 1992, MidWest Plan Service, Iowa State University, Ames, Iowa. (Out of print. No longer available.)

Conference Proceedings, Pesticide and Fertilizer Containment Symposium 2, MWPS–C2, 1994, MidWest Plan Service, Iowa State University, Ames, Iowa. (Out of print. No longer available.)

Order from NRAES, Cooperative Extension, PO Box 4557, Ithaca, NY 14852-4557. Phone: (607) 255-7654. Fax: (607) 254-8770. E-mail: <NRAES@CORNELL.EDU>. Web site: <WWW.NRAES.ORG>.

Appendix A

Post Frame Plan for a Chemical Storage

A post frame design of a farm chemical storage building is illustrated in figure A-1. The unit was designed for growers using primarily bulk storage of chemicals and provides rooms for mixing and storage. Rinsate storage may be contained under roof or not, as the producer desires. The rinsate storage area is surrounded by a one-foot high concrete curb forming a containment unit and, although open, is fenced.

The loading pad is roofed to reduce contaminated rainwater flow and is of sufficient height, with the half-monitor roof design to allow the egress of commercial chemical application equipment. In addition, for operators with boom sprayers, a rinse trough is provided on site for those not wishing to field rinse.

Before construction, an engineer should verify that the structure will withstand snow and wind loads at the building site.

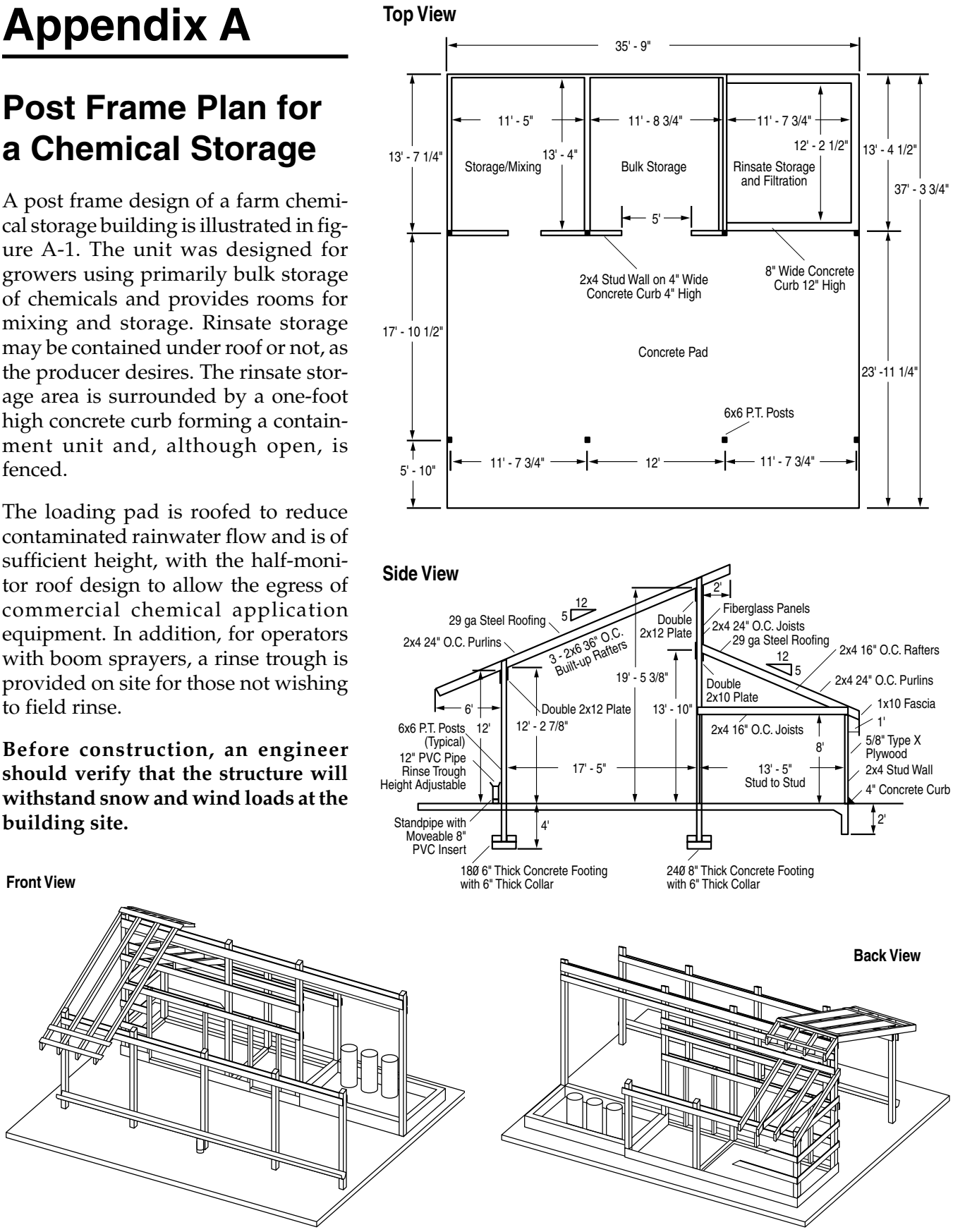

Figure A-1. Post frame design of farm chemical storage building.

Developed by James Scarborough, Associate Professor and Extension Specialist, Agricultural Engineering, University of Delaware. Before construction, an engineer should verify that the design will withstand snow and wind loads at the building site.

Appendix B

Companies That Distribute Equipment for Storage or Containment of Chemicals

The following is a partial listing of companies that provide equipment for storage/containment of chemicals.

Fume Hoods

Heat Systems, Inc.
1938 New Hwy.
Farmingdale, NY 11735
(800) 645-9846

Lab Safety Supply
P.O. Box 1368
Janesville, WI 53547-1368
(800) 356-0783

Pace, Inc.
9893 Brewers Court
Laurel, MD 20723
(301) 490-9860 (phone)
(301) 490-4860 (fax)

Safety Supplies (Including Spill Kits)

Direct Safety Co.
7815 South 46th Street
Phoenix, AZ 85044
(800) 528-7405

Global Occupational Safety
22 Harbor Park Drive
Port Washington, NY 11050
(800) 433-4848

Industrial Safety and Security Co.
1390 Neubrecht Road
Lima, OH 45801
(800) 537-9721

Lab Safety Supply
P.O. Box 1368
Janesville, WI 53547-1368
(800) 356-0783

New Pig Corp.
One Pork Ave.
Tipton, PA 16684-0304
(800) 468-4647

Portable Containment

Aero Tec Laboratories, Inc.
45 Spear Road Industrial Park
Ramsey, NJ 07446
(800) 526-5330

Hunter Agri-Sales, Inc.
Box 2
Coatsville, IN 46121
(317) 386-7277

Portable Containment, Inc.
P.O. Box 400
Antigo, WI 54409
(715) 627-4826

Safety Storage, Inc.
2301 Bert Drive
Hollister, CA 95023
(800) 344-6539

Chemical Sump Pumps

Precision Tank and Equipment Co.
RR#2 Box 42
Athens, IL 62613
(217) 636-7023

W.W. Grainger, Inc.
Local branches throughout the U.S.

Chemical Storage Tanks

Nalge Co.
75 Panorama Creek Drive
P.O. Box 20365
Rochester, NY 14602-0305
(800) 625-4327

Poly Processing Co.
Box 4150
Monroe, LA 71211
(318) 343-7565

Poly Liners

Fabrico Environmental Liners, Inc.
4222 South Pulaski Road
Chicago, IL 60632
(800) 621-8546

Storage Cabinets, Lockers, and Buildings

Durham Mfg. Co.
201 Main St., P.O. Box 230
Durham, CT 06422
(800) 243-3774

Eagle Mfg. Co.
2400 Charles St.
Wellsburg, WV 26070
(304) 737-3171 (phone)
(304) 737-1752 (fax)

Haz-Mat Containment Corp., Inc.
712 Bancroft Rd. No. 216
Walnut Creek, CA 94598
(800) 943-6510

Haz-Safe Buildings
P.O. Box 606
Leechburg, PA 15656-6006
(412) 842-2130

The Haz-Stor Co.
2454 Demster St.
Des Plaines, IL 60016
(708) 294-1000

Safetec of America, Inc.
1055 East Delavan Avenue
Buffalo, NY 14215
(800) 456-7077 (phone)
(716) 895-2969 (fax)

Safety Storage, Inc.
2301 Bert Drive
Hollister, CA 95023
(800) 344-6539

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