



Planning Farm Shops

Vern Hofman
Agricultural Engineer

Dr. Kenneth Hellevang, PE
Agricultural Engineer



S
544.3
N2
A8
3. 266



NDSU EXTENSION SERVICE

North Dakota State University, Fargo, ND 58105

MARCH 1994

An efficient farm shop is essential on a modern farm. The farm shop serves a multitude of roles, including equipment maintenance, fabrication and service, parts and tool storage, and as an office. Parts storage and service is becoming more important as service centers and parts distributors become more scattered and it may be necessary to travel many miles to get needed parts.

A shop provides a place to service, assemble, repair, adjust and modify equipment and keep tools in one location for field and farmstead operations. Overall, farm labor efficiency can be significantly improved by providing good shop facilities which will encourage preventive maintenance of equipment. Good preventive maintenance is known to significantly extend machine life and reduce the chances of costly downtime. It is also possible for the operator to construct or rebuild equipment to suit particular needs.

The shop can be the headquarters for farm management, employees and farm callers. A heated office with washroom and space for farm records and catalogs is an added convenience for efficient farm operations.

Location on Farmstead

A producer will likely go in and out of the shop more times than any other building on the farmstead except the house. It should be located convenient to the house, machine storage and other farm traffic routes. It should be near the center of farm operations.

The shop should be at least 150 feet from the house to allow for easy equipment movement. This helps keep noise away from the living area and still provides for security. During the growing season, equipment will be moved and parked near the shop, which can detract from the appearance of the house and landscaping if too little room is provided. Machinery too close to the house can create a safety hazard if small children are around.

A shop should be situated on the farmstead so it is accessible only by passing near the farm home. Locate large doors so that valuable tools and equipment are not visible from the main road. Also, large doors should face away from the prevailing winter winds. In North Dakota, they should face south and/or east.

Good drainage is important. Shop floors should be at least 12 inches above existing grade and slope approach aprons 3 to 5 percent away from the shop.

Figure 1 shows ideal farmstead layouts with shop, machinery, livestock, grain and feed storage areas indicated. The booklet MWPS-2, "Farmstead Planning Handbook," gives additional information about complete farmstead planning.

Planning the Shop

Factors that need to be evaluated in a shop include: space requirements, equipment layout, access, storage, insulation, wiring, lighting, heating, ventilation, and office requirements.

The size and type of structure that houses the shop, the need for an outdoor work area and the kinds of tools, equipment and supplies that are used will vary according to individual needs. The ideal farm shop should include a large concrete slab outside where a farmer can park a machine for service or repair in warm weather. Tools and equipment should be conveniently located in the shop so equipment attachments can be installed or removed quickly. Welding equipment should be located near the large door so repair jobs can be completed outside without having to move the welder or use extension cords with the welder. The ramp needs to be equipped with floodlights so machines can be serviced night or day. The inside area should be large enough to run most equipment inside for major repair jobs.

A survey of 300 North Dakota farmers suggests that the minimum shop size is related to the size of the farm. The results are shown in Table 1.

Table 1. Minimum Shop Dimension Based Upon Farm Size

Farm Size (Acres)	Shop Size (sq. feet)	Shop Width (feet)	Shop Length (feet)
1,000	1,680	40	42
2,000	2,000	40	50
3,000	2,300	46	50

The suggested building width should be at least twice the door width. The recommended door width should provide at least 2 feet of clearance for equipment being brought into the shop. A smaller service door is suggested so that the large door does not have to be opened for routine activities. The door height should provide at least 1 foot of clearance above machinery. Suggested minimum sizes are shown in Table 2.

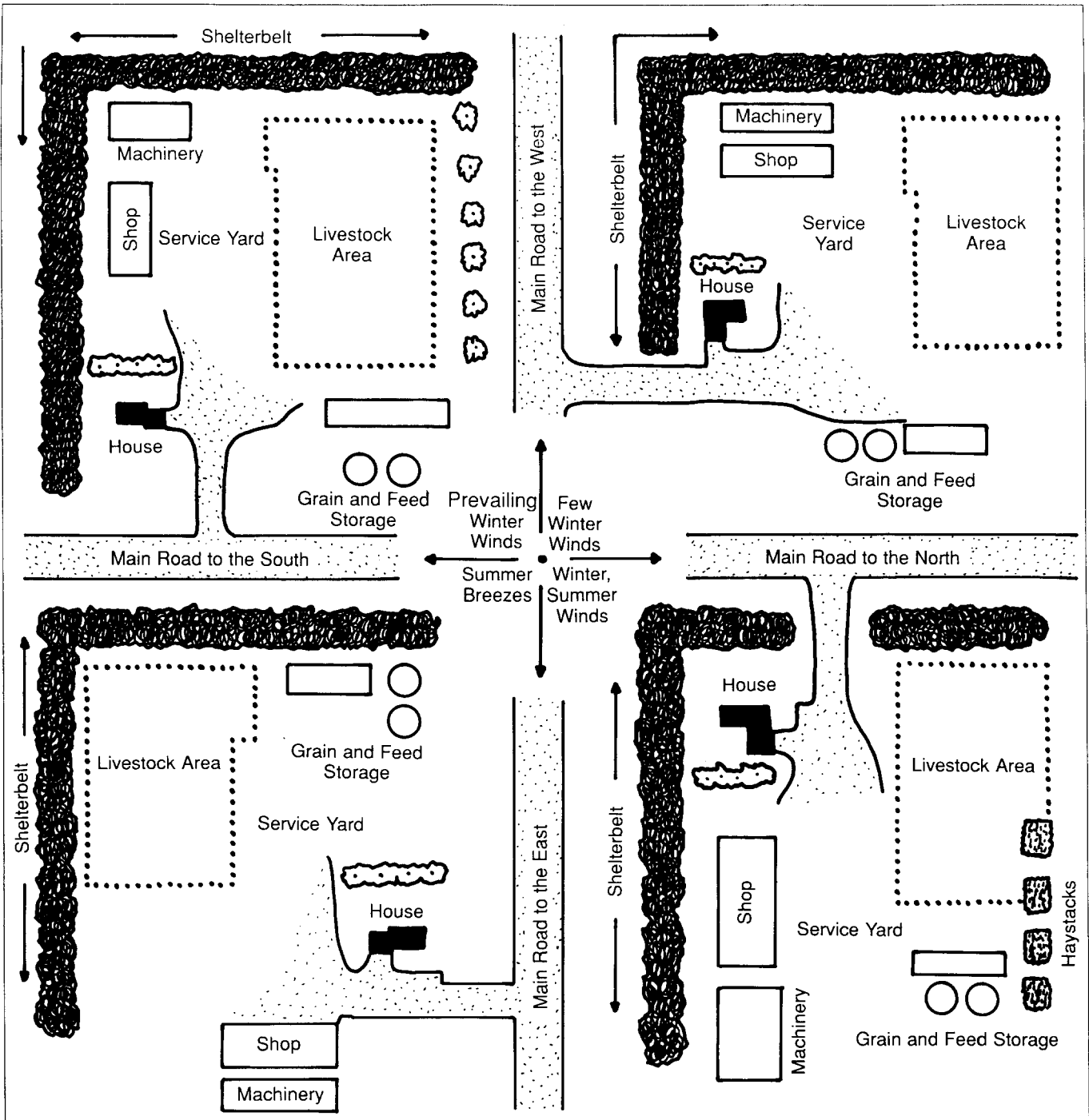


Figure 1. Farmstead layouts in relation to main roads.

Table 2. Suggested Minimum Farm Shop Door Dimensions

Farm Size (Acres)	Door Dimensions	
	Door Width	Door Height
1,000	20'	14'
2,000	24'	15'
3,000	28'	15'

A concrete apron to work on equipment outside the shop is encouraged. This provides a firm surface to park machinery on and reduces the amount of dirt carried into the shop on implement tires.

Table 3. Suggested Dimensions of Concrete Apron Outside Shop

Farm Size (Acres)	Apron Width (Feet)	Apron Length (Feet)
1,000	20'	40'
2,000	25'	40'
3,000	30'	46'

All machinery access door frames should be protected both inside and out with concrete filled metal pipe at least 4 inches in diameter and 4 feet high. Place them in concrete 12 inches out and in line with the door frame or slightly inside the door.

Many older shops are remodeled farm buildings that may not be well suited to today's large farm equipment. Most existing farm structures are extremely difficult to convert to a modern shop because of the need to install a large door. An exception to this may be a relatively new machinery storage building where one end is often used for a shop. A concrete floor, ceiling and insulation can be added and a wall installed to partition off the machine storage area. An insulated overhead door may be needed plus heat and better lights installed to make the shop more usable.

Insulation

When a farm shop is built, most farm operators intend to use it during the winter. Insulation in a shop is extremely important to maintain a comfortable working environment at a reasonable heating cost. Many operators keep the temperature in the shop between 40 and 50 degrees at all times. Maintaining a temperature in the 40s helps keep the heating cost down, plus

if desired it takes only a short time to heat the shop to a comfortable working temperature. If an operator is working on machinery, a comfortable temperature is usually about 55 to 60 degrees.

The minimum recommended insulation level for a heated shop is an R-value of 15 to 20 in the walls, 25 to 30 in the ceiling and 10 for the doors. It is also recommended to insulate the foundation with at least 2 inches of polystyrene insulation (R-10 to 12) to a 24 inch depth. This helps keep the floor warm, reduces heat loss and eliminates frost buildup on the inside perimeter concrete.

Windows installed in the shop sidewalls and overhead doors should contain double glazing. Better insulating value is obtained with triple glazing.

A vapor retarder of 6-mil polyethylene should be installed between the inside wall panel and the insulation to keep moisture out of the insulation. Six-mil is recommended as it withstands rough handling and tearing better than 4-mil. A vapor retarder should be installed in the ceiling as well as the walls.

A suggested wall section is shown in Figure 2.

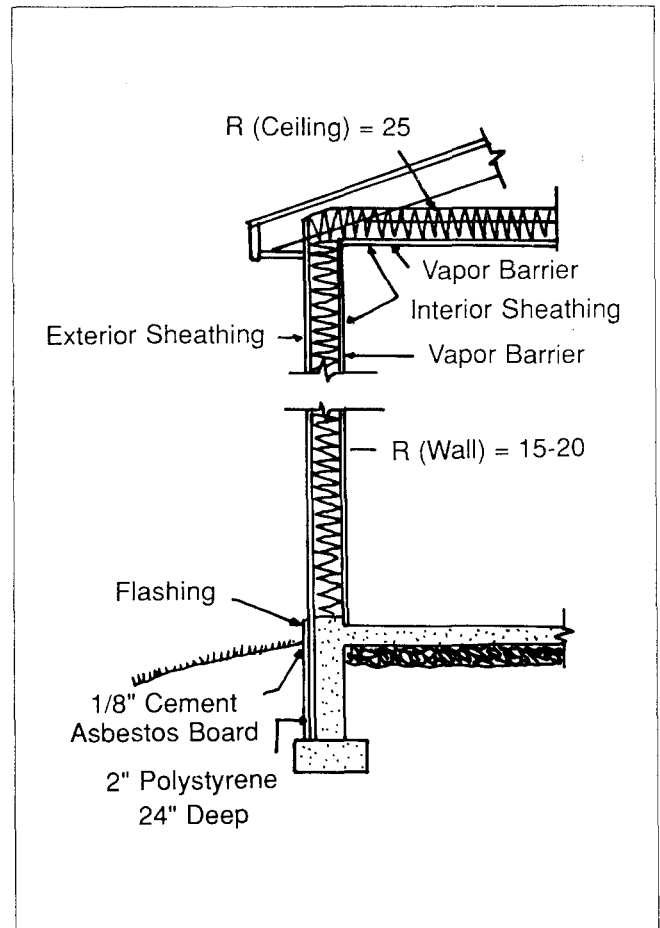


Figure 2. Sidewall construction with insulation.

It is recommended to cover the lower 8 feet of all walls with plywood or metal paneling to protect the insulation from damage. Covering the entire inside wall with plywood or metal panels helps improve looks. A ceiling at eave height provides an attic area that is easily and economically insulated with blow-in insulation. Roof vents should be installed to provide 1 square foot of vent space for each 300 square feet of ceiling area.

Electrical Service

An electrical service of 200-amp, 240-volt is the minimum recommended for all shops. In larger shops, a larger service may be needed. This will provide power to operate power tools, an air compressor and welding equipment.

Where motors 1/2-HP or larger will be used, install a separate circuit to serve no more than two 1/2-HP motors, and no more than one 1-HP or larger motor.

Install a 50-amp or larger 240-volt outlet for the welder. Two or more outlets properly located will make it possible to use the welder in most locations when working on machines inside the shop. Have at least one welder outlet near the large door so welding can be done outside.

Unless thoroughly familiar with wiring, always have a qualified licensed electrician do the work. Electrical wiring will need to be approved by an electrical inspector before electrical service will be connected by a power supplier. Remember that 120 volts can be very dangerous and improper wiring often is the cause of serious fires.

It is recommended to install 120-volt duplex outlets every 4 feet along work benches and every 10 feet along walls. If power tools are located away from walls, it may be best to install outlets in the floor or suspend them from the ceiling.

Ground fault interrupters (GFI) are recommended on all single phase 15- and 20-amp convenience outlet circuits. The National Electrical Code requires GFIs on all 15- and 20-amp receptacle outlets installed on the outside of a building and near wet areas. A GFI senses a fault in a circuit to protect the user of an electrical tool from electrocution. These faults may be caused by deterioration or accidental damage to electrical equipment. A GFI protects against the hazards of ground faults by monitoring the current balance in a "hot" conductor with the current in a neutral conductor. If the current in the neutral conductor equals that of the "hot" conductor, a ground fault

does not exist. If current leakage occurs and the current flow in the neutral wire becomes less than the current in the "hot" wire, a ground fault exists. Upon sensing this current difference, the GFI trips and opens the circuit almost instantaneously. Ground fault interrupters are available as portable units, circuit breaker-interrupters or receptacle units.

Electrical Lighting

Plenty of light in a farm shop is essential. Good lighting over the workbench is necessary for detailed work.

Some natural lighting is recommended. A window installed in a wall facing the entrance to the yard and small windows in the overhead doors allow workers in the shop to see arriving visitors. Windows in the door are also handy for those inside the shop to see when a door should be opened to drive equipment inside.

Fluorescent lighting is recommended in heated shops. In cold shops, fluorescent lights are extremely slow to start. Recommended lighting levels are shown in Table 4.

Table 4. Recommended Lighting Levels

	Foot Candles	Fluorescent Lights (watts/sq. ft.)	Incandescent Lights (watts/sq. ft.)
General	30	1/2	2
Bench	50	1	4
Office	70	1.5	6
Detailed Work	100	2	8

If it is desired to use mercury vapor or high pressure sodium lamps for general lighting, install at the level of 0.8 watts per square foot for mercury vapor lamps and 0.4 watts per square foot for high pressure sodium lamps. These types of lights are slow to come on, so if mercury vapor or sodium lamps are installed a few incandescent lights may be helpful for initial lighting.

For outside lighting, provide for 3.0 foot candles of illumination. Install a 300- to 400-watt photo-cell controlled mercury vapor lamp or 200 watt high pressure sodium lamp over the outside entrance about 20 feet above ground.

Ventilation

Ventilation is necessary to remove welding smoke and engine exhaust. A welding hood with a fan that will move about 1,000 to 2,000 cubic feet per minute for each welder that is being used is recommended over the welding area. If vehicles are to be operated in the shop for a period of time, an exhaust hose through the wall may be adequate or a small suction fan pulling exhaust through a tube from the exhaust pipe may be a better solution. Usually a fan capable of moving about 250 cfm per vehicle through the pipe should be adequate.

General ventilation in a shop is usually not needed. Opening and closing doors will usually provide adequate ventilation.

Heating System

The size and type of heating system will depend on the size of the shop and how often large doors will be opened and closed. Many types of heating systems are used in shops, including hot water pipes embedded in the floor, electric resistance cables in the floor, infrared and forced air furnaces. Most are powered by electricity, propane, coal, wood or fuel oil. Waste oil furnaces are becoming popular due to the difficulty in disposing of waste engine and transmission oil in rural areas. Several of these heaters are designed to burn No. 1 or No. 2 fuel oil as well as waste oil. This provides an alternate fuel supply if waste oil supplies are not adequate.

It is up to the farm owner to decide the most economical fuel source and whether to use forced air or water pipes in the floor for heating the shop.

If an operator decides to install a heating system in the floor (electric heat cables or hot water pipes), it is recommended to install a ceiling hung furnace near and to the side of the big door, directing the heat to the back of the shop. This furnace is extremely helpful for quick temperature recovery when the big door is opened in cold weather. Floor heating system temperatures should not exceed 75 to 85°F. Warmer temperatures will cause foot discomfort after a period of time.

Waste oil furnaces are excellent for forced air heating systems. They are economical to operate, provide a quick heat source and will utilize fuel oil as well as waste oil to warm the shop. Coal furnaces are economical to operate if a coal source is available. One disadvantage is that they may not be as fast for bringing the temperature back up as propane or fuel oil forced-air furnaces. However, in a shop this may

not be a problem. If a coal heating system is used, it may be best to place the furnace in a small building adjacent to the main shop.

The heating system for a shop should provide about 50 BTU per square foot per hour. A 40 by 50 foot shop would require about a 100,000 BTU per hour heating system. If a floor heating and forced air system is used, the heating requirement may be divided between the two if using both systems is desired. More information on floor heating systems is available in Extension Circular AE-1014, "Hot Water Floor and Space Heating," which is available from your local county agent or from Extension Agricultural Engineering at North Dakota State University.

Tool Benches and Parts Storage

Keeping tools in place in a shop is often difficult. The advantages of having tools hanging on tool panels with the tool outlined include tools being easy to find and easy to put back in place, and one glance at the panel will tell what tools are missing.

The arrangement of tools on the panel is a matter of individual taste. Generally, it works best to have the various types of tools grouped together. Extra tools can be stored in drawers built into the workbench.

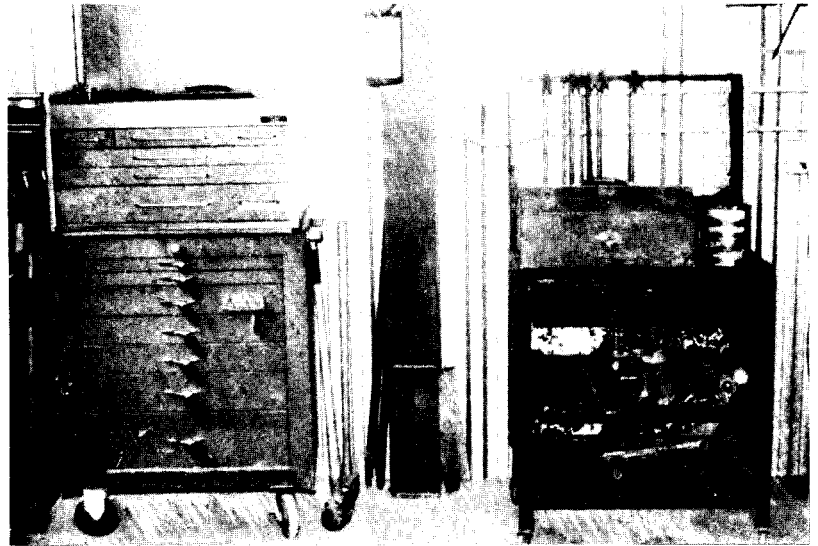
Pegboard is satisfactory for tool panels providing the type of hangers used can be permanently anchored into the holes. Three-quarter inch plywood can be used. It is thick enough so nails, screws, or other fasteners, can be used for tool hangers without locating studs behind the panel. If the inside wall is covered with 3/8 inch plywood, an additional plywood panel will give enough thickness for tool hangers.

Workbenches should be 34 to 38 inches high and adjusted to the principal user's height. The bench depth is normally 24 to 30 inches and should be anchored securely. Many individuals place a bench along the south wall and install windows above the bench for natural lighting. Windows reduce wall space for tool panels so large windows usually are not recommended. At least part of the bench should be covered with a steel surface for durability.

Large, free standing power tools are best placed near the welding and repair area. Do not place grinders, drills, or similar equipment in building corners. This reduces access when working on large pieces of equipment. They are usually best located near the repair and welding area. Provide stable bases, but do not fasten tools to the floor. This helps allow flexibility



Tool panel and storage unit.



Portable Tool Cabinets

for working on large equipment. Wrenches and a workbench should be close to the welder, drill, and grinder if possible.

The welding area near the big door should include a solid metal welding table, but do not fasten it to the wall or floor. Line the wall in the welding area with 1/2 inch plywood and cover flammable wall liners with sheetmetal. Another alternative is to cover wall liners with 1/2 inch cement plasterboard.

A wall-mounted air compressor near the large door saves floor space and is convenient to service equipment outside on the apron. Air outlets on a pipeline mounted on the perimeter of the building provide for convenient use of air tools and air pressure over the entire shop. Install water traps and drains on pipelines to remove the moisture.

Storage space is commonly inadequate and parts bins and cabinets are often shoved into the work area. Freestanding parts storage units work well for filters, spare parts, bolts and screws. Wall mounted racks also work well. Other racks should be included for long

pieces of wood, metal and pipe. Standing long pieces on end utilizes wall space well and provides for easier removal of stock material as compared to laying pieces horizontal. It is suggested to sectionalize the vertical rack so material can be chained into compartments to avoid falling.

Office

The extent of the office will vary considerably depending on need. A minimum recommendation is a desk, telephone and storage for service manuals and records. A restroom with running water and shower is optional, along with a washing machine for greasy or pesticide contaminated clothing. It is convenient to have an exterior entrance into the office, and this provides a good entrance for farm visitors. The office will usually need additional climate control such as baseboard heating panels.

Floor Designs

If washing of machinery is to be done in the shop, a good drain system is a must. The simplest type of floor drain is to slope the floor to the center and to the doorway. This can cause problems with ice freezing along the bottom edge of the door if ice melts off vehicles that are stored in the building. A center floor drain with an oil and sludge collector is a better option but is more difficult and expensive to install. An example of this type of drain is shown in Figure 3. The drain is designed to catch oil on top of the water and collect heavy solids in the bottom of the pit. This type of drain will collect these materials before they flow into the drain field as long as it is cleaned on a regular basis.

Another type of drain that works well in the service bay is a long narrow type which slopes 0.1 inch per foot of length.

Fire Prevention

Every farm shop should be equipped with one or more approved fire extinguishers; at least one unit should be located near the walk-through door. This provides convenient access when moving from or toward a fire. The chances of putting out a fire are good during the first few seconds after it is discovered, so easy access to a good fire extinguisher may mean the difference between extinguishing a fire or the shop burning down.

Fires that occur in farm shops can be caused by electrical power tools or grinding sparks igniting flammable liquids. Water should never be used to control electrical fires. Water on flammable liquid fires will tend to spread the flames.

The best extinguisher to use on electrical or flammable liquid fires is a 2 1/2- or 5-pound dry chemical type or a carbon dioxide type. They produce a smothering effect and are easy to use. Both types of extinguishers contain a material that does not conduct electricity. Dry chemical or carbon dioxide extinguishers will knock the flames down on a wood or paper fire and give temporary control or until a better extinguisher is available. If the electric power to the shop can be disconnected, water can be used on wood or paper fires.

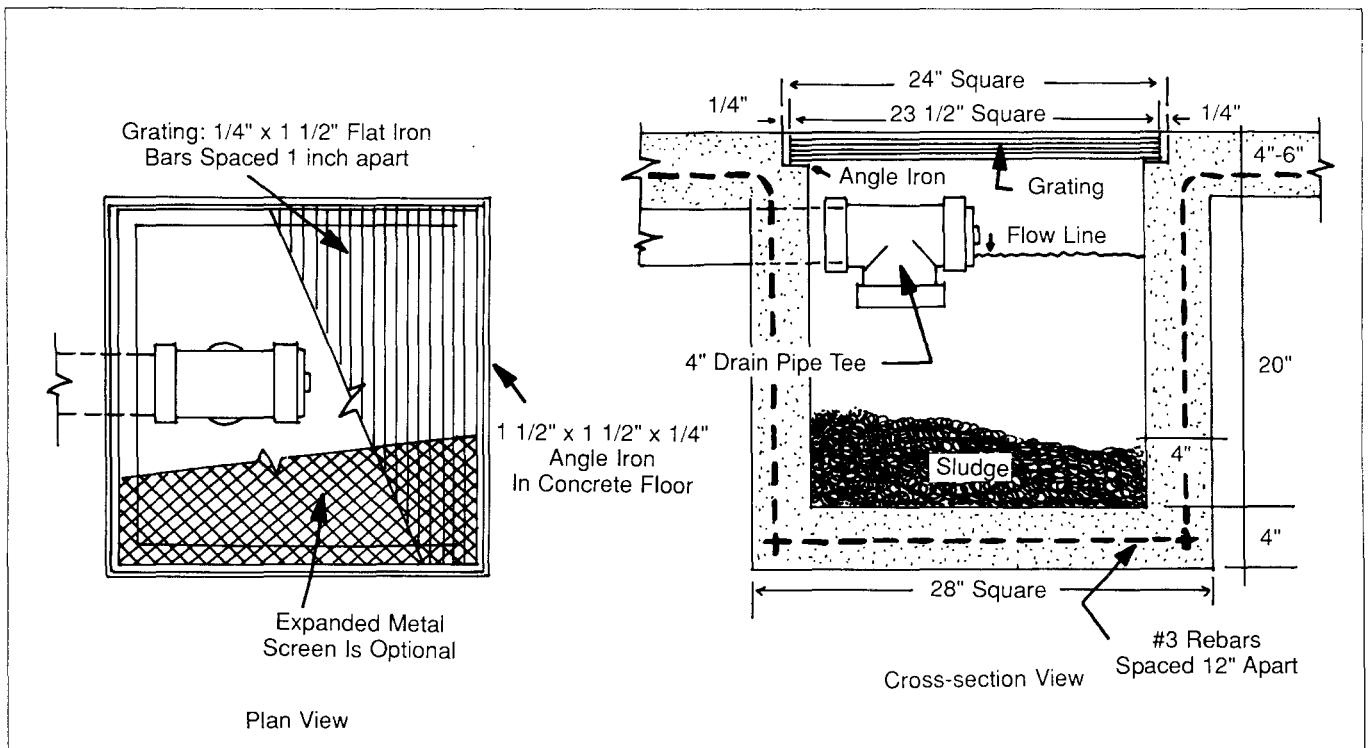


Figure 3. Floor drain.

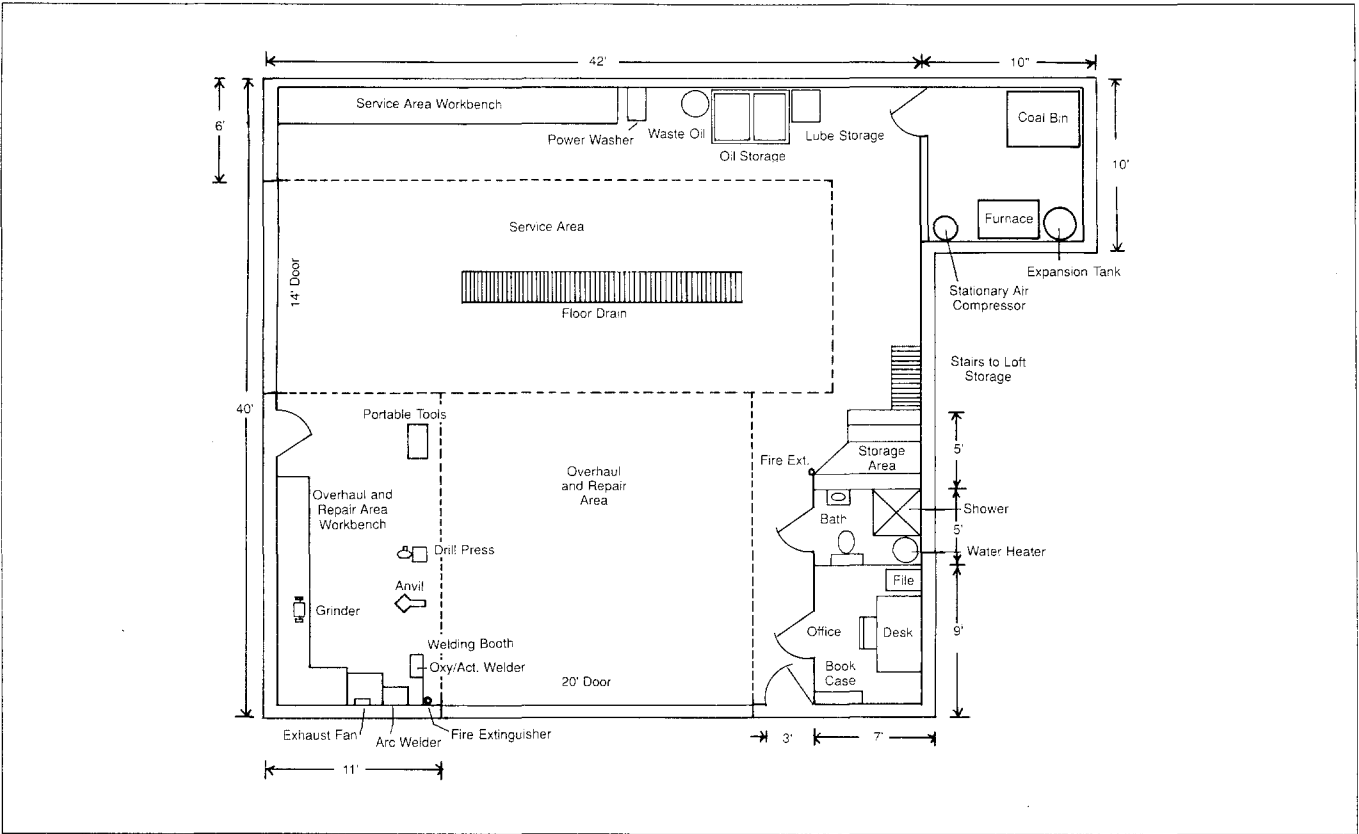


Figure 4. Floor plan for a 1000 acre farm shop.

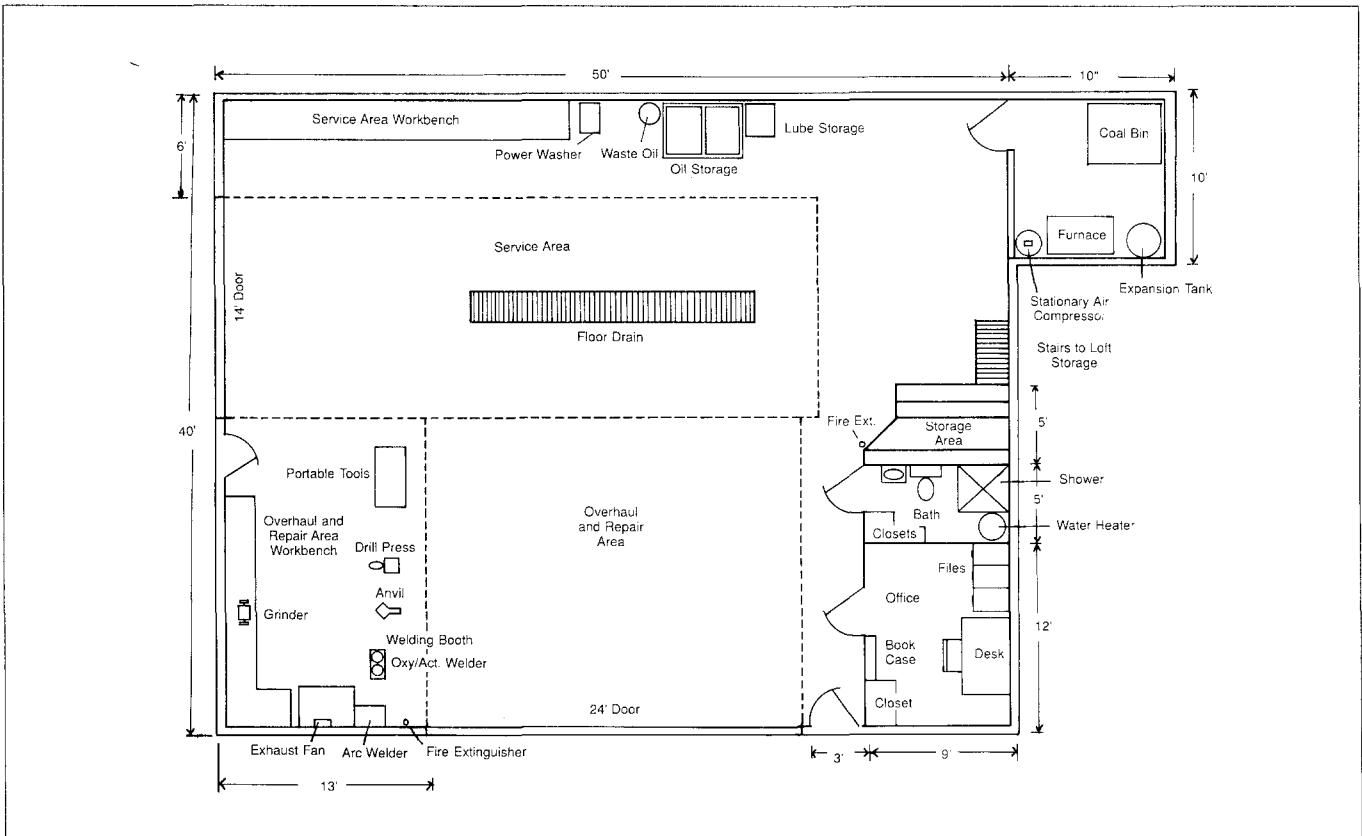


Figure 5. Floor plan for a 2000 acre farm shop.

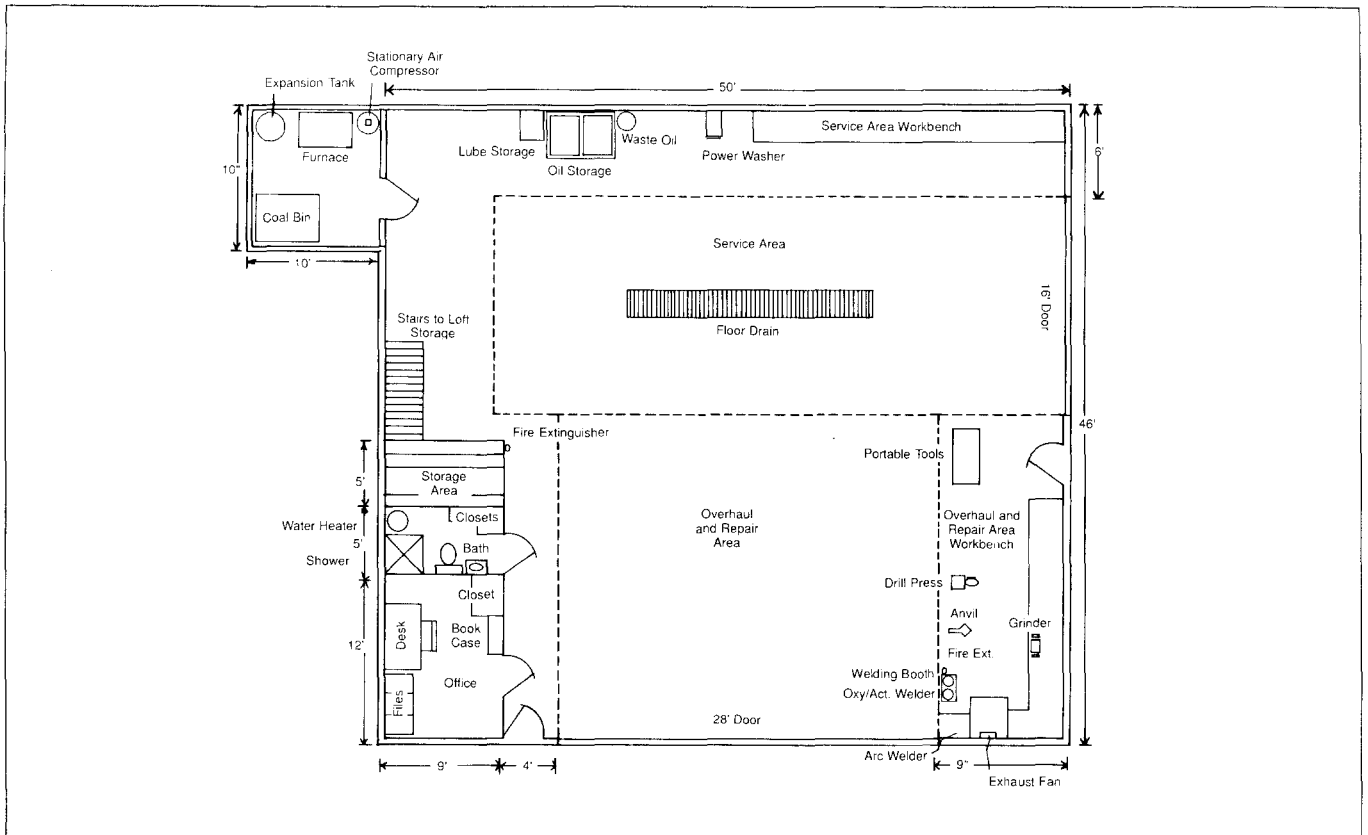


Figure 6. Floor plan for a 3000 acre farm shop.

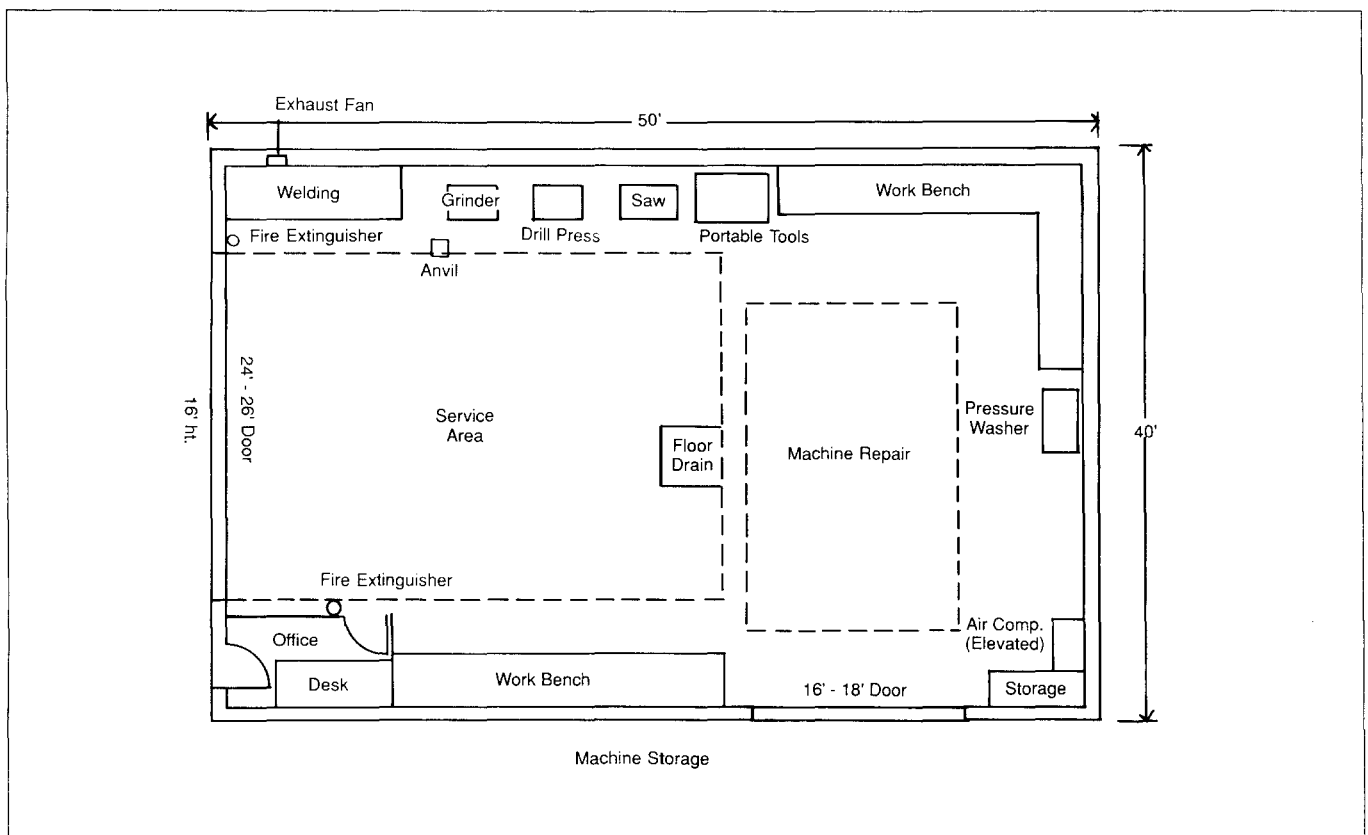


Figure 7. Floor plan for a 40' x 50' shop on the end of machine storage.

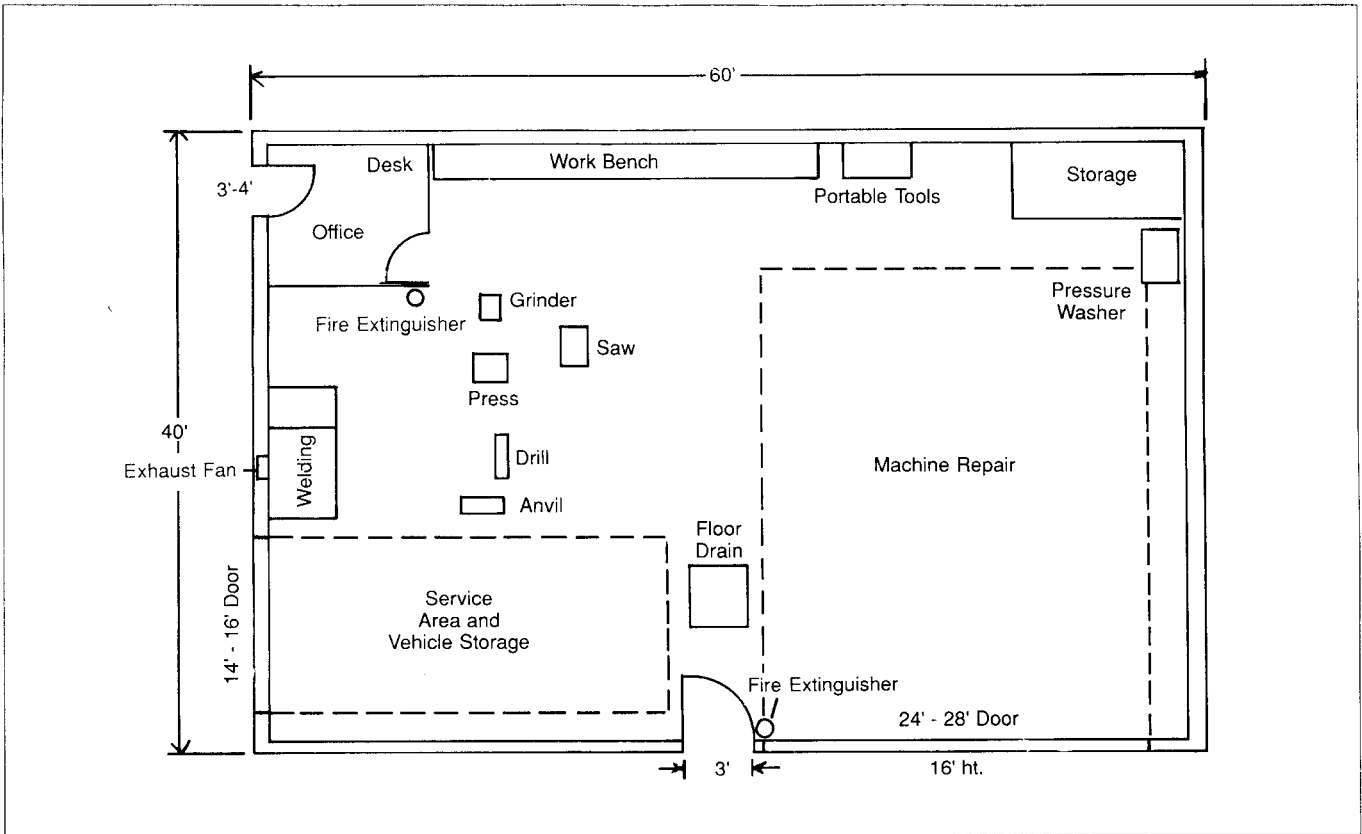


Figure 8. Shop floor plan 40' x 60'.

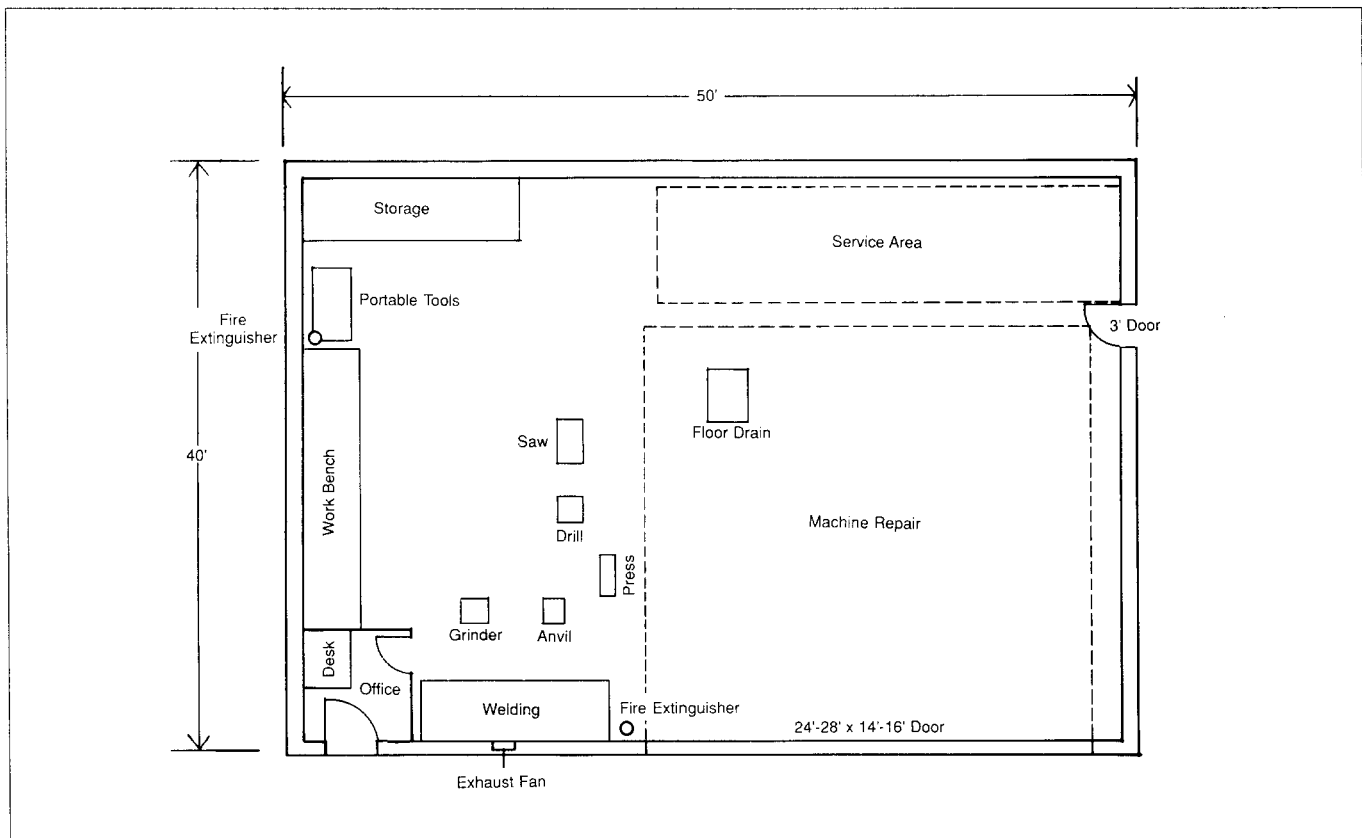


Figure 9. Shop floor plan 40' x 50'.

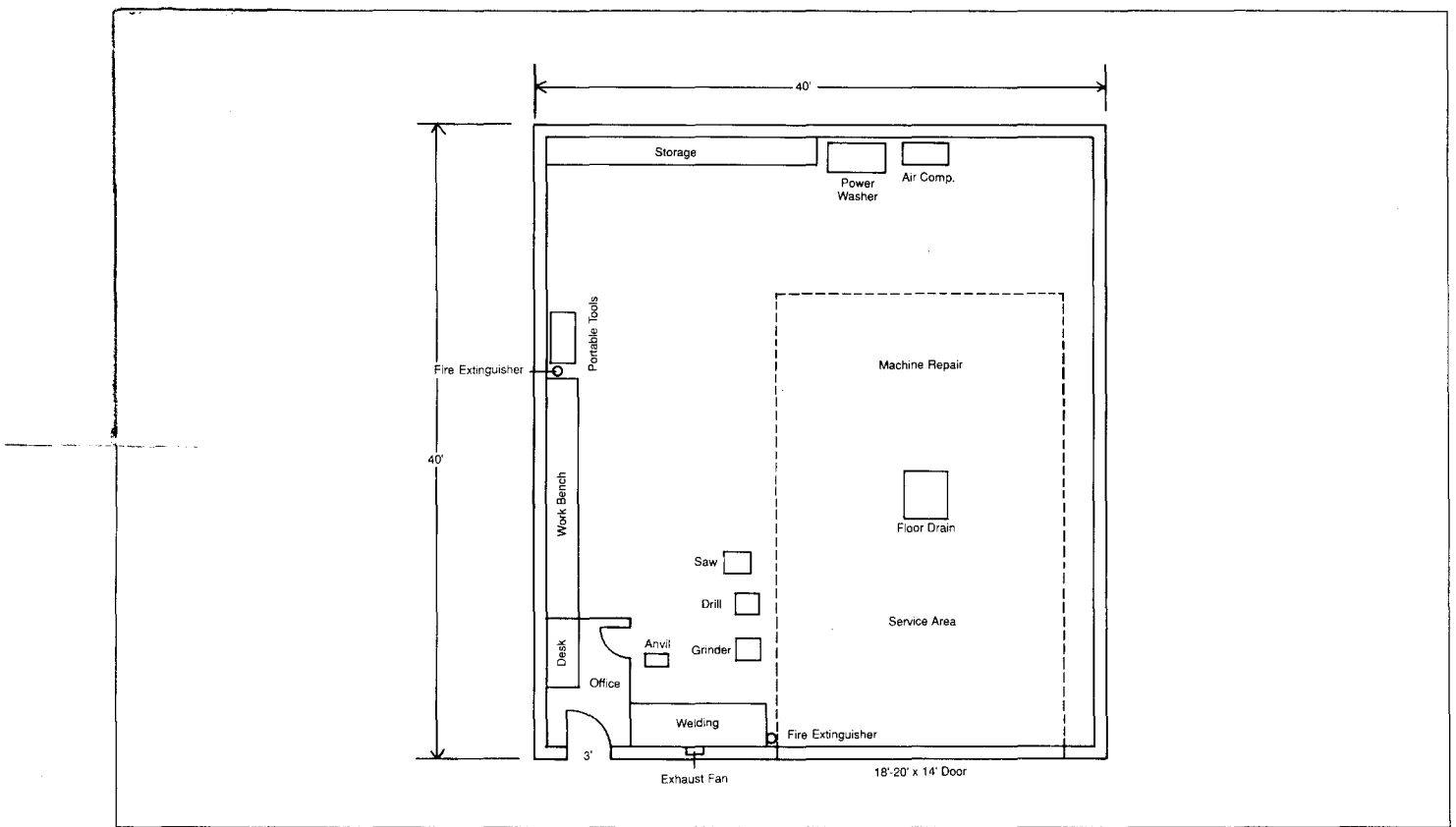


Figure 10. Shop floor plan 40' x 40'.

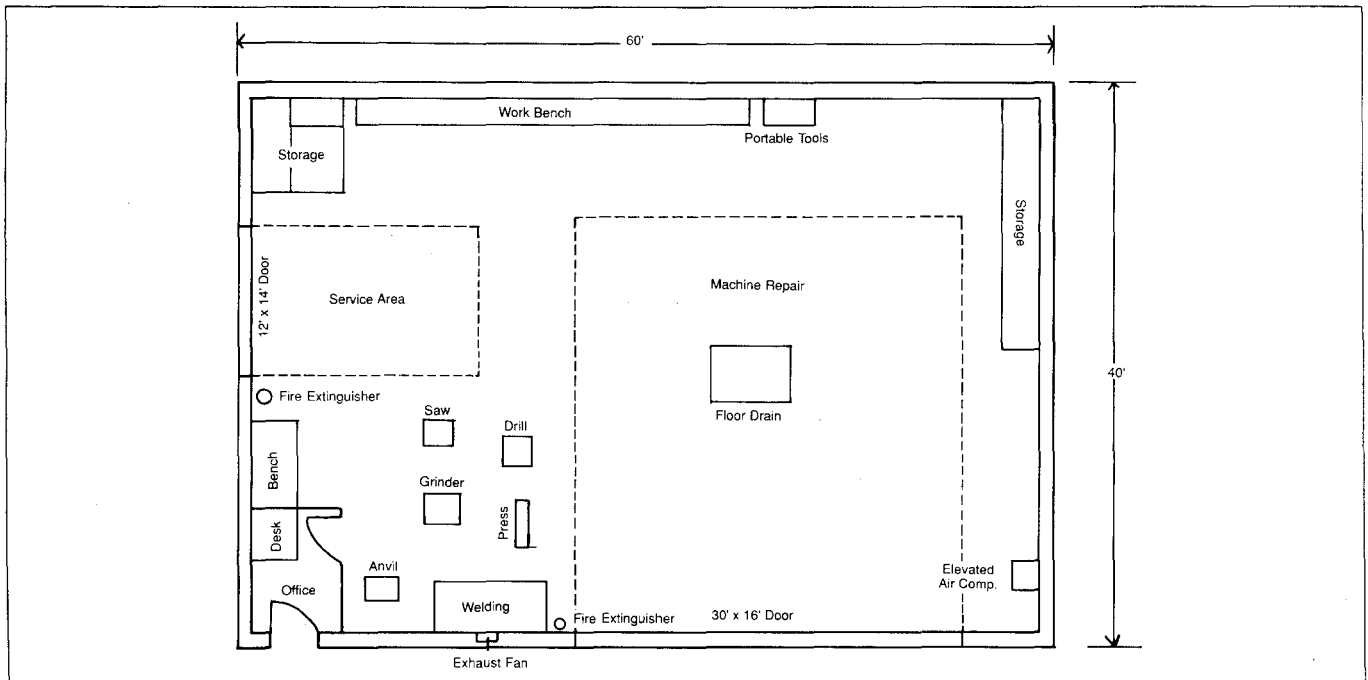


Figure 11. Shop floor plan 40' x 60'.

Helping You Put Knowledge To Work

NDSU Extension Service, North Dakota State University of Agriculture and Applied Science, and U.S. Department of Agriculture cooperating. Robert J. Christman, Interim Director, Fargo, North Dakota. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. We offer our programs and facilities to all persons regardless of race, color, national origin, religion, sex, disability, age, Vietnam era veterans status, or sexual orientation; and are an equal opportunity employer.

