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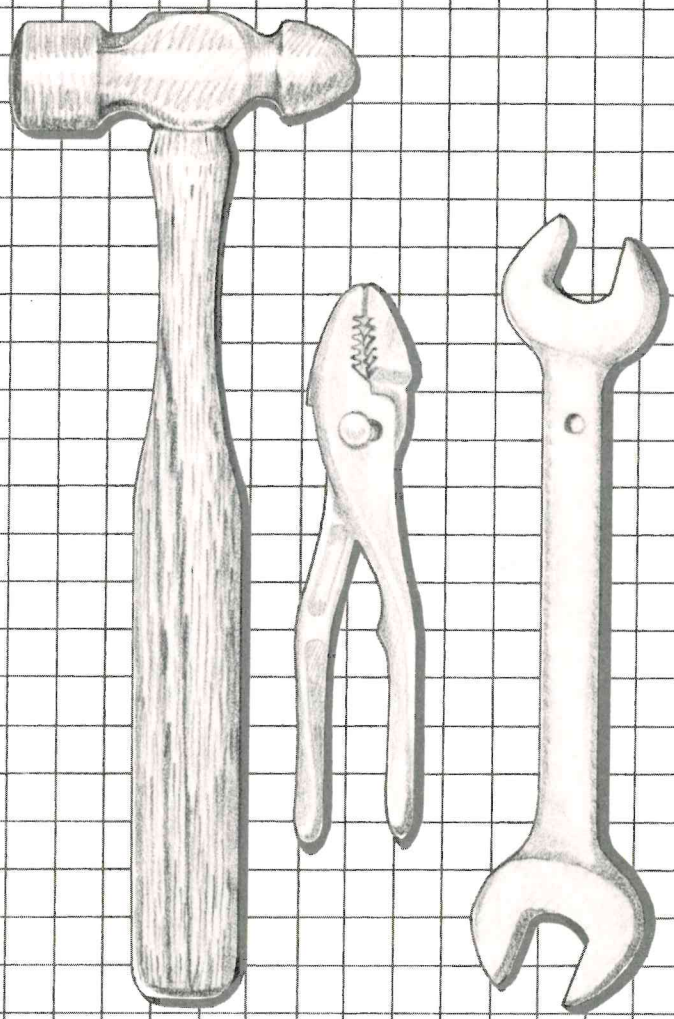
NRAES-16

PLANNING FARM SHOPS



COOPERATIVE EXTENSION
Northeast Regional Agricultural Engineering Service

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CONTENTS

Building Design

All farmers need a shop for maintenance, repair and construction. The extent of need depends on:

- Size of operation
- One's inclination to do mechanical work
- One's mechanical competency
- Availability of qualified persons to do the job for hire on a timely basis
- Cost and time required to hire the job done
- Economics of one's own time for maintenance work instead of for other purposes
- Cost of putting a mechanically skilled person on the payroll as compared to hiring jobs done
- Timeliness of service and maintenance of machines when work is done at the site as opposed to taking them to a shop for hire.

The size and type of structure that houses the shop, the need for an outdoor area, and the kinds of tools, equipment and supplies that can be used, will vary according to individual needs. Most farms, today, need a new shop building. A large enough existing building in good condition, remodeled into a well organized shop could meet a farmer's needs for a maintenance center. Remodelled garages or utility buildings are often too small for large equipment.

No attempt is made in this bulletin to design a model maintenance center; each situation is different. It does, however, discuss the basic concepts, design criteria, and the specifications for providing, equipping, and using a maintenance center for the farm.

GENERAL REQUIREMENTS

The design of the structure for the maintenance center is initially influenced by its geographic location with the particular wind forces, snow loads and insulation requirements of that location.

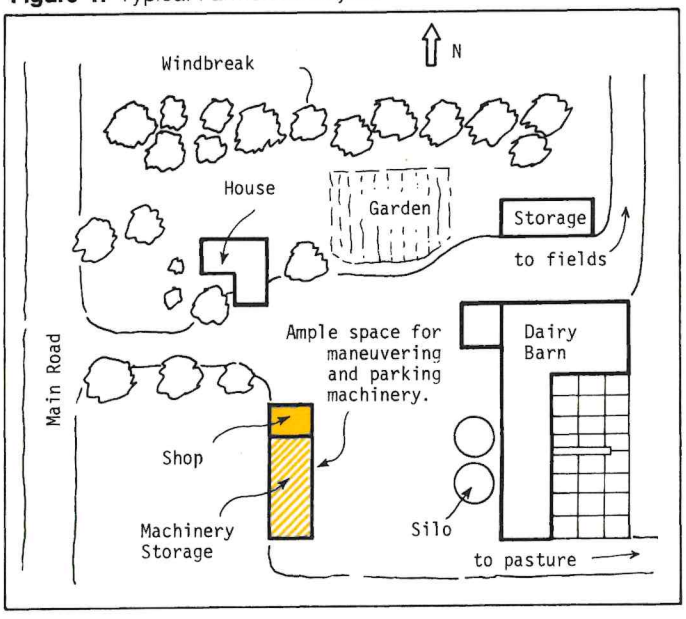
The building should provide shelter without unduly obstructing the work space. A safe place to work, of fire resistant construction, that is well lighted, ventilated, clean and comfortable is ideal. Electrical outlets should be planned for service and work areas where electrical tools, equipment and auxiliary lighting are used. Windows should be placed so wall space for tool cabinets is kept adjacent to the work areas.

SHOP LOCATION

Locate the farm shop:

- for easy access to the main road and to farm fields.
- close to the machinery storage; logically both are part of the same building.
- with ample space around it for maneuvering and parking machinery.
- so it can be fenced from livestock.
- at least 50 feet away from other buildings to keep a possible fire from spreading, as well as not interfere with their function.
- on a well drained site with space to plow snow out of the way in snowy areas.
- where electricity and, if desired, water can be run easily to it.
- next to a service lane for any large equipment that is used. The service lane should be at least 20′ wide, either paved or gravelled, and accessible to electric welder cables, oxyacetylene torch, air hose and a 120 volt electrical outlet.
- with protection from wind with a shelter belt of trees.
- so it has a straight-in driveway to the service door.

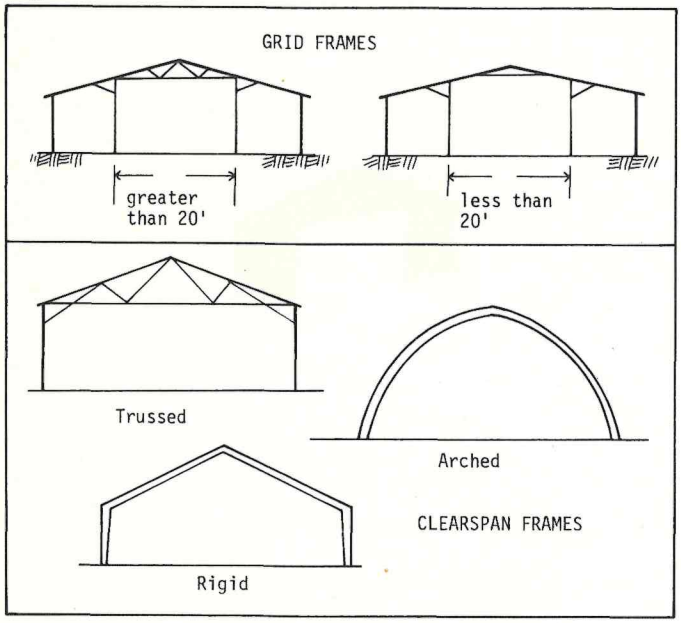
Figure 1. Typical Farmstead Layout



BUILDING FRAMES

A well organized shop may be kept in either a clear span building or a well planned grid frame building that has interior posts (Figure 2). The unobstructed, clear span structure allows great flexibility in the use of space. Doors may be placed almost anywhere. Several types of construction are shown in Figure 3.

Figure 2. Building Frames



A grid frame structure requires coordinated planning with the posts. Also movement is somewhat restricted by the posts. However, they can be used to separate the service area and the work areas. Posts also provide convenient locations for electrical outlets adjacent to service and work areas. Only the service area needs clearance for the highest machine to be serviced.

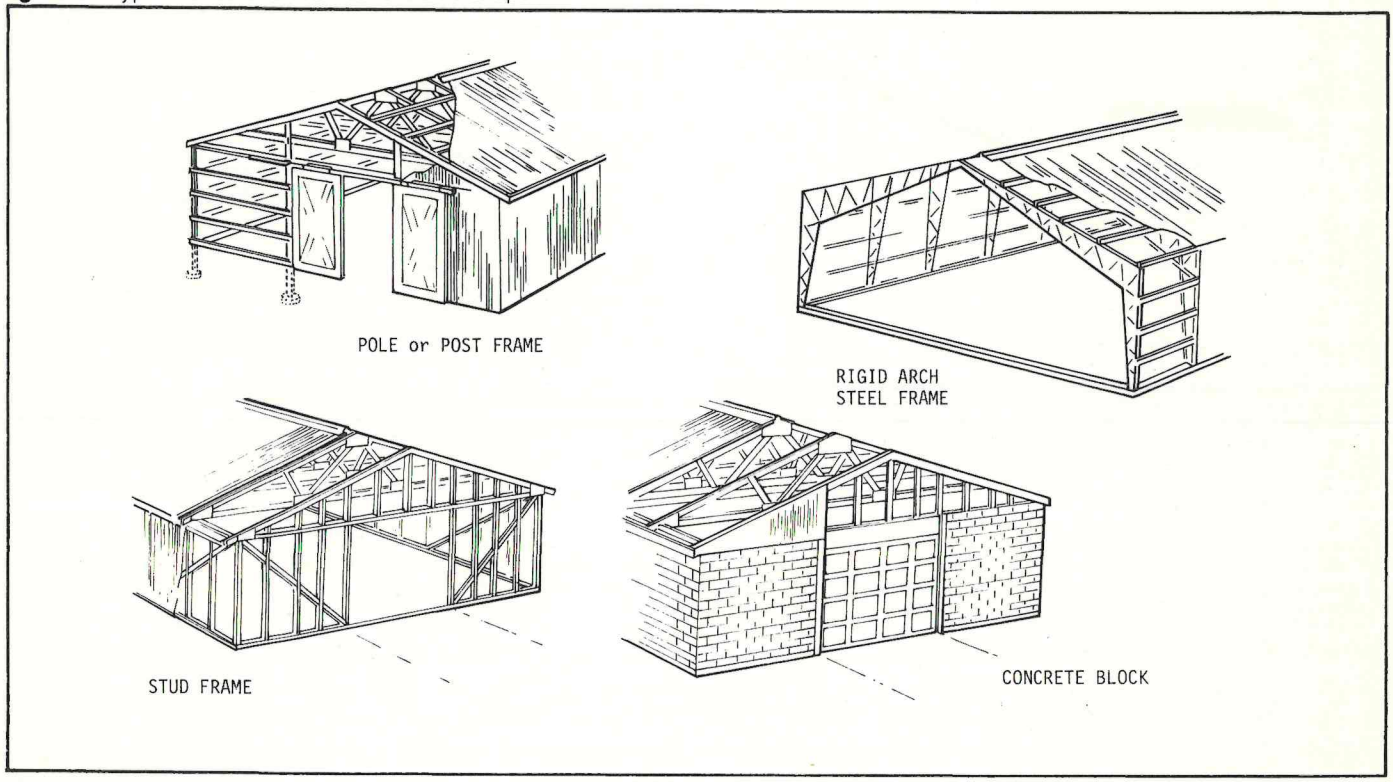
A high service entrance door can only be placed at either gable end of a grid framed building. This type of construction has several compensating advantages however. It typically has shorter structural spans and lower side walls which cost less than the same size clear span. Also lower side walls decrease the exposed area and thus reduce potential heat loss.

STRUCTURAL MATERIALS

Wood or steel are the principle framing materials. Wood truss roof frames may be combined with concrete block, cement tilt up, or pole type wall construction.

Sparks from grinders, welding, gasoline engines and other operations require that shops be fire resistant. When flammable insulation and framing material is used, plan to protect the wall and ceiling with fire resistant interior sheathing. It is sometimes required for insurance coverage. Protect the walls of welding areas, the service area ceiling where tractors with open exhaust stacks might enter, and any area where open flames are used. Flammables may be

Figure 3. Typical Structural Frames for Farm Shops



covered with a material that has at least a 15 minute fire rating such as:

- .014 inch galvanized steel
- .032 inch aluminum sheet
- ½ inch cement plaster
- ½ inch fire rated gypsum board
- ½ inch fire retardant treated plywood
- ⅝ inch exterior plywood
- ¼ inch asbestos board.

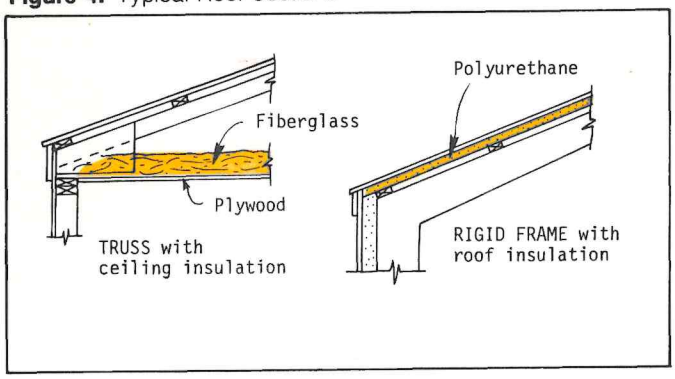
All these materials, except plywood, are easily damaged by impact, so they should be installed on a rigid backing such as plywood.

INSULATION

Plan to insulate shops in cold locations particularly where temperatures drop below freezing. The minimum comfortable temperature for shop work is 55°F. When the shop is closed down, lower temperatures can be tolerated; although it may be necessary to maintain the temperature above freezing if water pipes are exposed.

The thermal resistance or R value should be 12 to 15 for walls and 16 to 20 for roofs (Figure 4). When the roof is framed with trusses, insulation batts may be easily installed above a ceiling. Blanket insulation is suitable in a roof framed with rafters.

Figure 4. Typical Roof Sections



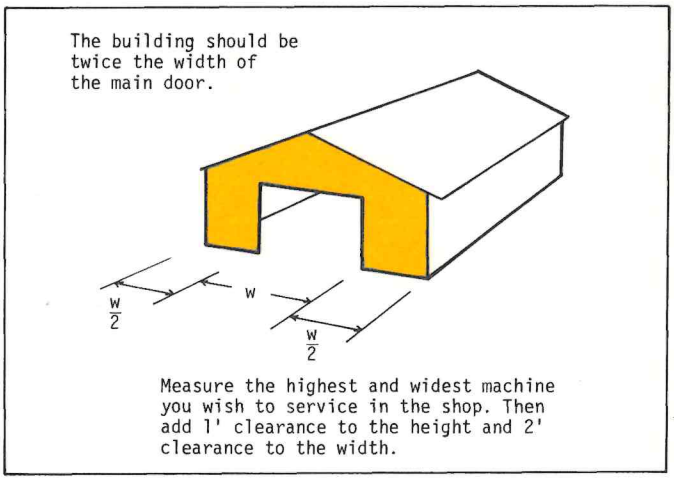
Install insulated doors with an R value of 4 to 6. Windows should be double glazed or fitted with storm sash. Weatherstrip both doors and windows. Install latches that close the large service entrance door tightly. Seal all structural cracks around door and window frames with caulking material.

Light weight blocks have better insulating properties than concrete blocks. The cores can be filled with granular insulation to reduce heat loss. Considerable heat loss takes place through the edge of a concrete floor. Perimeter insulation may be installed vertically along the foundation wall or horizontally under the floor, or sometimes in both positions to prevent this heat loss.

DOORS

One guide for shop design emphasizes the importance of easy access. First determine the size of the main door and its relative location in the farm courtyard. Then make the building twice the width of the door. The building should be at least as deep as it is wide.

Figure 5. Dimensions for the Shop Door



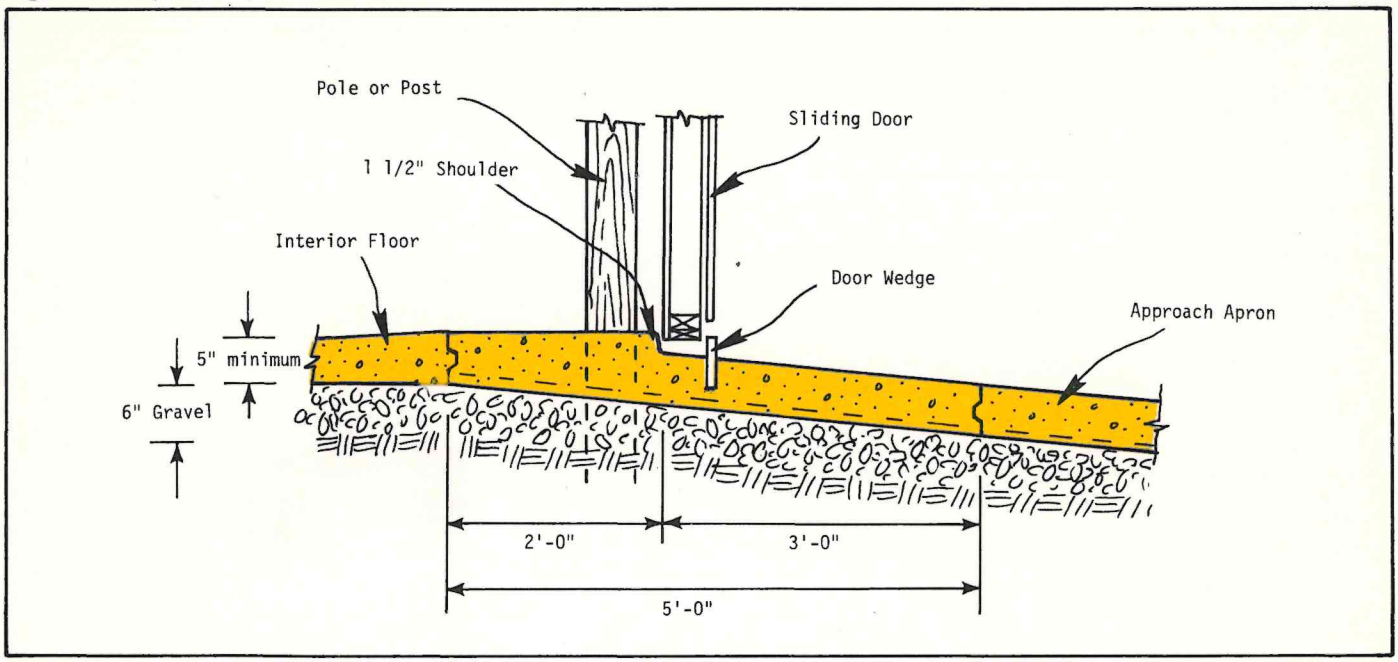
A 12 foot high by 16 foot wide service door is typical, but do not build by these recommendations without measuring your largest machine. Your door size requirements may be higher or lower, wider or narrower. Anticipate the highest and widest machine you may wish to service in the center, then add one foot clearance to the height and two feet to the width.

A large door requires costly hardware, and is difficult to keep weather tight. A compromise size of 10′ high by 15′ wide may be satisfactory if an outdoor service area is established for the occasional large implements.

The width of the door indicates the minimum width of the service area, the door height is the minimum ceiling height. A wood header over a 16′ wide door located in a side wall will be about 20 inches deep. The ceiling height then must be at least 20 inches higher than the door clearance. A service door in the gable end allows you to build a less expensive building with simpler header and lower ceiling.

Sliding, tracked, overhead and folded overhead service doors are available. None of these types form a good seal between the door frame and the door when closed. Figure 6 shows a concrete apron that gives a fair seal. Avoid operational problems by obtaining quality door hardware. The center-divided sliding door has the least operational problems. Sometimes, however, the building isn't wide enough for the track when the sliding door is installed in the gable end.

Figure 6. Shop Door Apron Cross Section



The service area behind the large door should be as wide or slightly wider than the door. This area provides space for building, maintaining or servicing a transportable machine or structure. It should have a minimum length of 24 feet; 30 feet is better. If a self-propelled combine is to be brought in, the service area should be at least 35 feet long.

One or more walk-in personnel doors are required depending on the surroundings of the shop. These doors often are used to enter adjacent areas and to reach them with an air hose or welding cables. These doors improve shop security as the large door can be locked and barred from the inside.

WINDOWS

Windows provide general daytime lighting and ventilation. Windows which tilt out from the top so incoming air is directed upward ventilate best. They also prevent excessive blow-in during storms. Windows can be grouped to light a particular area, such as a work bench. Window placement should be carefully planned to reserve wall space for cabinets in each work area. Steel or aluminum sashes require less maintenance than wooden sashes.

FLOORS

A floor made of quality concrete properly finished makes a considerable contribution to the utility of a shop. Tools are always out of the dirt, equipment is easily moved and cleanup is facilitated. A 5 inch thick concrete floor is strong enough for most farm shops. Reinforce with 6 × 6 – 10/10 wire mesh to prevent any cracks from opening up wide.

Place the floor surface a minimum of 6 inches above grade. Slope the land away from the building for good drainage. A sloped concrete pad in front of the door to the service area provides a clean vehicular entrance to the shop.

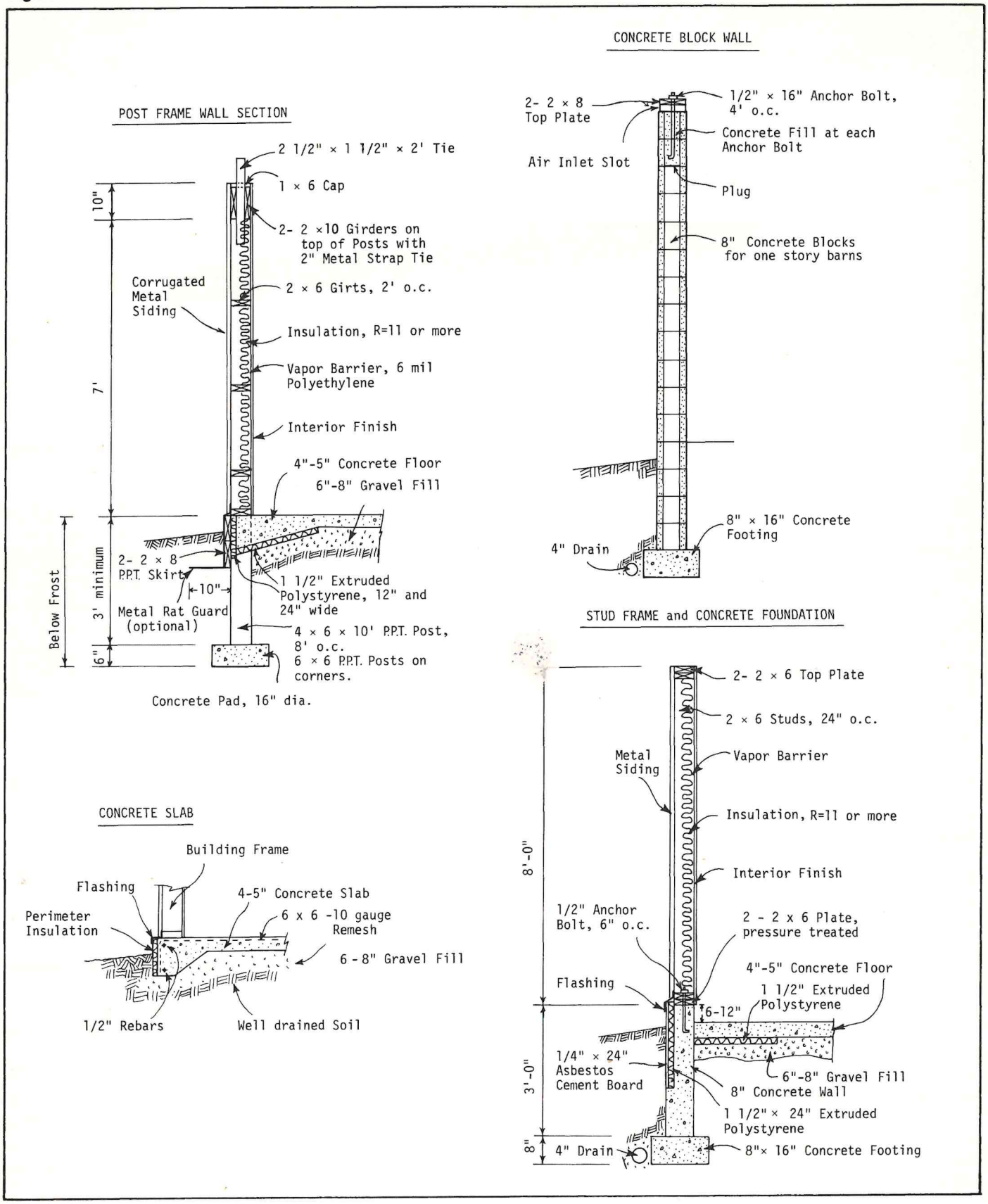
Remove all organic material from the floor area where concrete is to be placed. Install tile or perforated plastic pipe to drain any wet areas and for the floor drain. Place a well packed crushed rock base at least 6 inches thick.

A floor drain in the service area is essential for washing vehicles and to drain away melted snow. Run the drain pipe to an outside area where water will run away from the building. Slope the floor surface at least a uniform 2% toward the drain. In a large service area two drains may be needed. Drain oil in another area to keep oil from spilling into the drain.

FOUNDATIONS

Standard farm building foundations are shown in Figure 7. The drawings show a footing width of 16 inches which is adequate for all soil conditions on which a building is likely to be built. To prevent frost heaving the footing should be placed below frost or bedded with uniform sized gravel in which a drain line is placed. The shop structure is adequately supported with a pole frame set on a concrete footing, with a concrete foundation or with a reinforced well drained concrete slab. Note the footing insulation procedures as shown in Figure 7.

Figure 7. Wall and Foundation Cross Sections



Utilities

ELECTRICAL

A detailed floor plan is the key to laying out the electrical requirements for the shop. Install enough branch circuits to supply the amperage and voltage requirements for separate lighting circuits and for the electrical equipment and tools that will be used. Provide enough outlets for hand tools which may be used at each of the work benches. The arc welder is usually the critical item for determining the voltage and amperage of the service entrance. Lights will often be on when the welder is in use and should be considered in the computation of minimum service amperage.

Generally an individual branch circuit must be supplied for each piece of large stationary electrical equipment. Some items, such as the welder and the air compressor, may be used in several places, and require more than one special electrical outlet. For the floor plan shown in Figure 9, a combination of wall and overhead outlets could be used. In a grid frame building the interior posts may be used as outlet mounts.

Install all electrical wiring according to the National Electric Code. Install proper grounding and ground fault interrupters as recommended by the code.

LIGHTS

Good lighting requires both general light and spot lights. Fixtures for lighting are usually mounted on the ceiling. If the temperature of the shop will be 55 degrees and over, fluorescent lights can be used. A continuous row of double tube fluorescent fixtures with open reflectors mounted 5 feet above the work bench gives adequate light for most non-precision jobs. The same lighting arrangement with rows of fixtures 8 feet on center and 8 feet above the floor provide adequate general lighting in work areas. In the service area lights are mounted 12 feet high (or more) for clearance. For adequate general lighting continuous rows of open reflector, triple tube fixtures, spaced 12 feet on center, are needed. The general lighting for each work area should be controlled by a separate switch to conserve energy.

Work areas where precision work is to be done need higher intensity spot lighting. A four tube fluorescent fixture which is four feet long and hung 3 to 4 feet above the work area will usually provide enough light. Two such fixtures hung about 3 feet apart may be needed for the most precise work. Spot lighting can also be used on equipment such as grinders, lathes and drill presses. Provide portable spot lights for the service area.

HEATING

A heater is necessary for winter comfort in northern areas. A wood burning stove might be all that is needed if the water supply is protected from freezing. If extensive woodworking is done, the wood scraps will supply a large part of the fuel. Most stove dealers have information on safe stove installation that lists required clearances and protection from combustibles.

Many other types of space heaters, either suspended or free standing, can be used providing the fuel is available. Thermostat or manual controls may be used. If water piping is exposed, temperatures must, of course, be kept above freezing. Follow the safety provisions for the type of heater which is installed. A heating system output of 30 Btu per square foot of floor area per hour is adequate in northeast USA, if the shop is insulated to the standards suggested in the insulation section.

Figure 8. Minimum Clearances for Wood or Coal Stoves

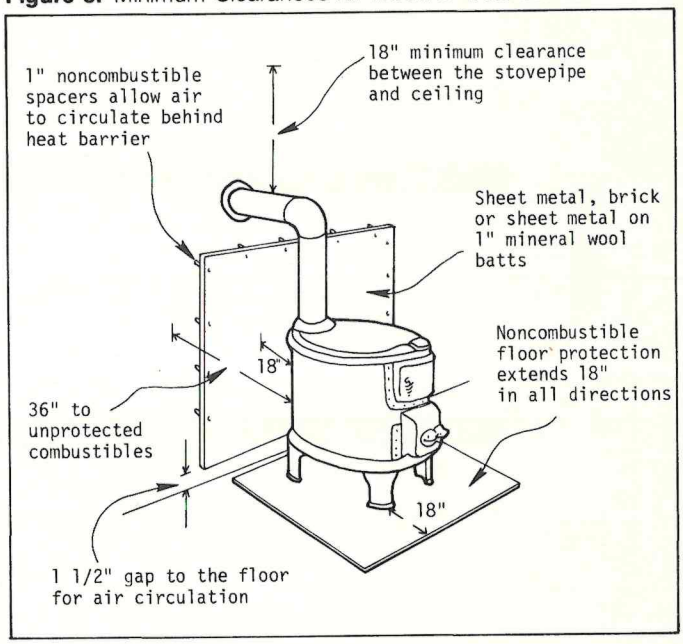
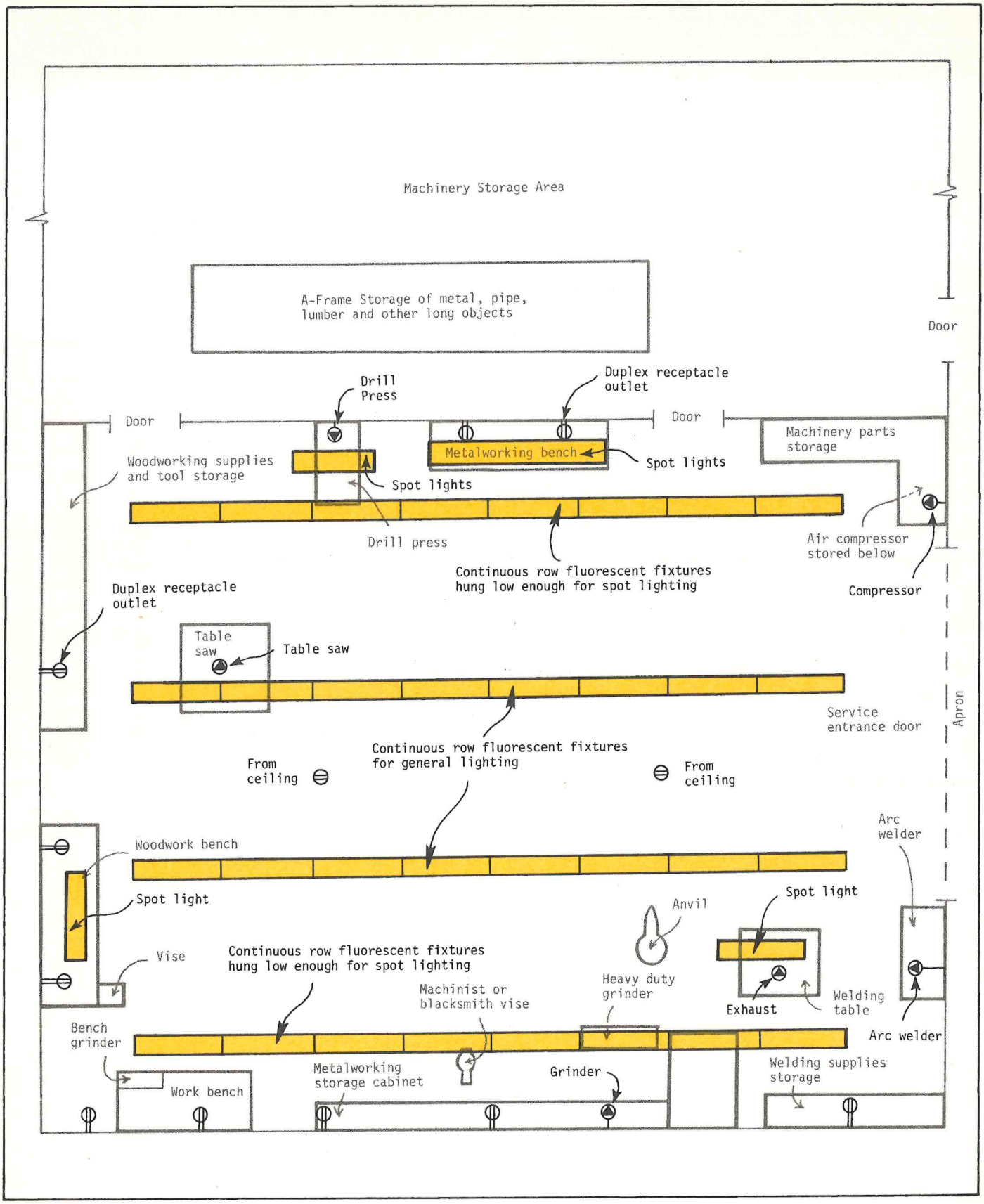


Figure 9. Shop Floor Plan showing Electrical Requirements



PLUMBING

Plumbing in a shop may be as basic as a cold water pipe with a faucet to which a hose can be attached. An available tap and hose is convenient for washing equipment as well as a good fire extinguisher for wood, hay etc. A minimum 10 gallon per minute (gpm) at 30 psi is needed for limited fire-fighting; 20 gpm at 60 psi is preferred.

A washbasin is desirable for washing hands after doing work in the shop. If the shop is a continuous place of work for one or more persons, a toilet should be added.

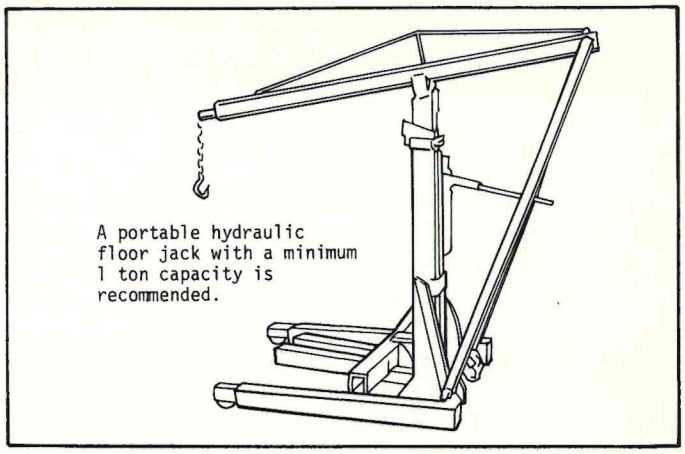
Wherever water is available, a drain is needed. An open drain to an outside run off area is adequate for a faucet and washbasin. If a toilet is installed, the waste water system then requires a septic tank and field or other type of waste disposal device.

SHOP HOIST

Shop work includes occasional lifting, moving and unloading of heavy machine parts and other objects. A hoist should be selected to accommodate the heaviest object to be lifted. The capacity should be conspicuously posted on the suspension frame to prevent overloading. The minimum lift range required is generally the distance from truck bed height to the floor. The lift control should be fairly precise to allow for the occasional alignment of bolt holes.

When a jack crane hoist is used, casters on the legs provide travel capability. An overhead track or other type of suspension supported by the structural frame may also be installed for limited travel of a hoist. If a hoist is attached to the building frame, it must be designed for the anticipated load. A truss or beam which supports a hoist must be considerably stronger than the trusses and beams that are only used to support the building. One way to increase the strength of the building frame is to double the trusses at hoist suspension points and to distribute the hoist load over four or more trusses.

Figure 10. Portable Hydraulic Jack



VENTILATION

The welding area and any areas where engines are run require positive ventilation. One exhaust fan mounted in the wall can sometimes serve both areas. If only one of these operations occurs at one time, a fan rated to deliver 500 cfm at a static pressure of .5 inches of water is adequate.

Air should flow across a welding table and away from the person doing the welding. If the welding table is set against the wall, the exhaust fan may be attached to a horizontal duct with a long, narrow intake slot that extends the length of the table and is mounted on the wall. The system should include a duct to remove engine exhaust. A damper must be installed to switch the air flow to either the welding table or the engine exhaust removal system.

If extensive woodworking is done, provide an exhaust and collection system for dust. Positive collection tubes can be hooked up to sawing and sanding devices so air is ducted to a cyclone type separator and the dust is dropped in a bin or hopper.

General ventilation of the shop can be adequately controlled by manual adjustment of windows and doors.

Space Requirements

Three basic types of work are done in a farm shop, namely metal, engine and machinery, and wood. There should be a separate grouping of tools, supply storage and work area location for each of these types of work. Soldering, plumbing and electrical work can be done in the metal area. Plumbing and electrical, as well as concrete work, are most likely done on a job site away from the maintenance center, so separate work areas are not needed for these kinds of work. A typical floor plan is shown in Figure 11.

Metalworking area. Electric arc and oxyacetylene welding stations are usually the nucleus of the metalworking area. This equipment is portable, but storage space should be provided for it in the shop. There must be a physical barrier between the electric arc and oxyacetylene welders so that an electric arc cannot be accidentally struck on the gas tanks and cause a possible explosion. An exhaust fan is needed for this area.

Locate the welding station near an exit door of the maintenance center so the welders can easily be moved to outside work. At the same time the metal-working area should be close to the indoor service area.

An anvil, blacksmith vise, and heavy duty pedestal grinder should be placed near the welders and welding table. Store metal working tools and supplies nearby. The top of the work bench should be metal or wood covered with heavy gauge sheet metal. A work bench near the drill press is useful to hold objects being drilled. The drill press table can be raised higher than the work bench so that a long piece can extend over the bench as it is being drilled.

Engine and machinery work area. This area is most logically located along a side or end of the floor area provided for engines and machinery. The top of the work bench or benches should be metal or wood covered with heavy gauge sheet metal. Grease, oil, gasoline and other solvents are much easier to clean from metal than wood. Also, wood soaked with these materials presents a serious fire hazard. Store tools and supplies nearby.

The chain hoist should either be installed in this area or, if portable, be easily moved into it. This area is a logical place for a floor drain and the rest of the maintenance center should drain to it. In addition this area is usually the best place for the air compressor.

Woodworking area. Keep this area free of all metal, petroleum products, machinery and engine repair parts, etc. A runoff table is needed for the table saw to cut long lumber lengthwise. A table is also needed with a radial arm saw to support lumber for cross cut sawing. Be sure these tables are exactly the same height as the saw table tops. A work bench with a heavy wooden top and a woodworking vise are very desirable.

PLANNING TEMPLATES

Space requirements for typical pieces of shop equipment are presented in Appendix A on templates, scaled ¼" = 1 foot, and coded to indicate grouping of equipment by area of use. Each piece of equipment has three space requirements—the **equipment** itself, the **operator space** immediately surrounding the equipment, and the **workpiece space** or outer area required to manipulate the materials being used.[1]

Use the templates to layout space for the equipment as follows:

1. Draw a floor plan of the shop on graph paper with ¼" squares, using a scale ¼" = 1 foot. Mark permanent features such as chimneys, doors, windows and posts. Glue the floor plan of the shop to cardboard.
2. Cut the templates for the required equipment from this bulletin. If a piece of equipment has not been included in this bulletin, a template can be made from graph paper at a scale of ¼" = 1 foot. Templates are not provided for tool cabinets since they do not generally take up floor space. If the measurements of your equipment differ from those of the templates provided, make adjustments on the templates, or make a new template.
3. In some cases, it may be necessary to reverse the workpiece space to extend in the opposite direction than that shown. Turn the template over and trace the equipment and operator space requirements.
4. Arrange the templates according to the arrangement rules. Pin the templates to the floor plan. This will provide you with an approximate layout of equipment. Minor alterations can be made when the actual equipment is being placed.

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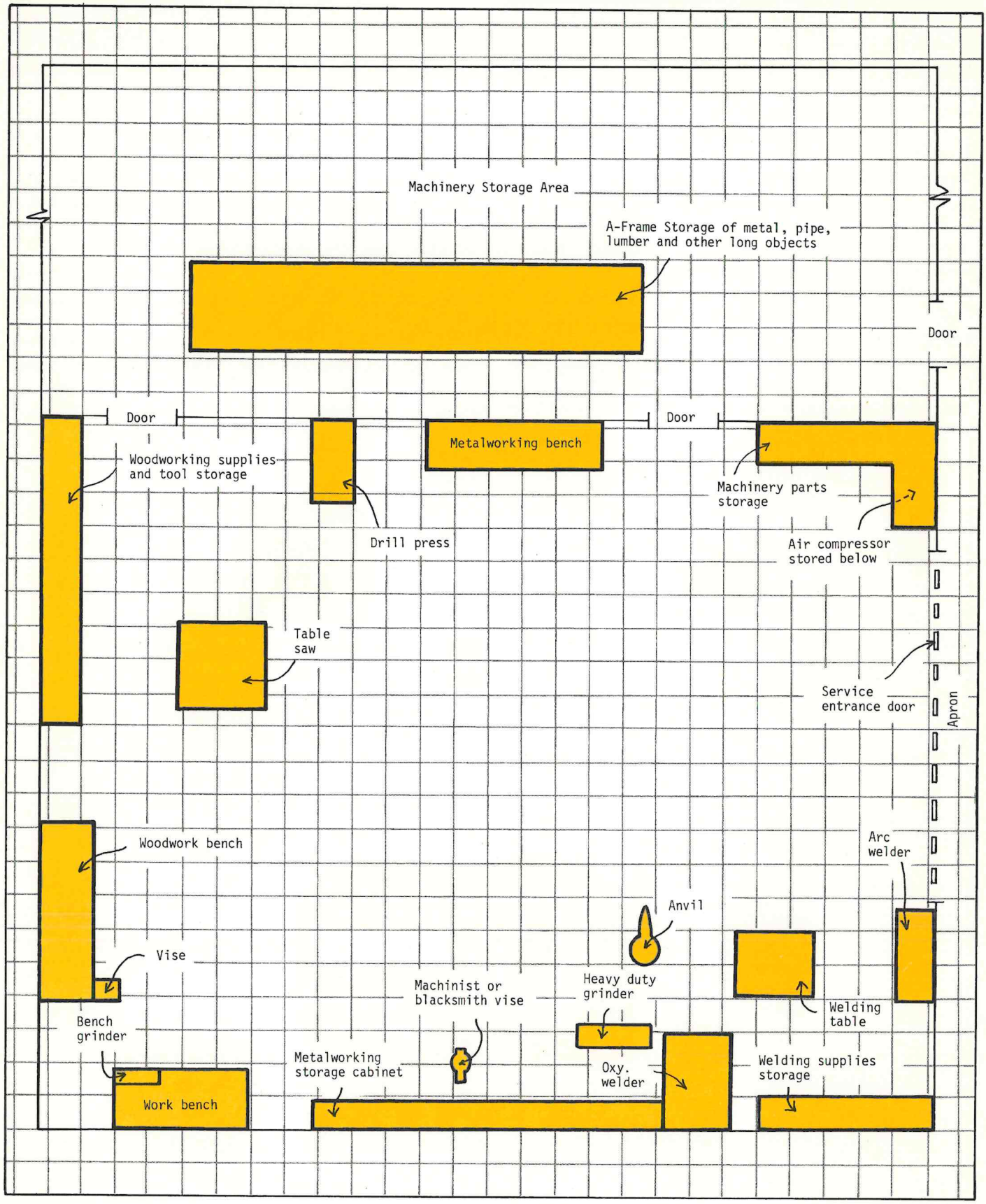
[1]Template dimensions for operator space have included an allowance for larger than average people. Measurements are from a point on the equipment that determines the space required and will remain fairly constant for varying makes and sizes of equipment, for example, the face of a pipe vise, the face of a grinding wheel, or the center of the table on a drill press.

Figure 11. Typical Floor Plan for a Farm Shop



TEMPLATE ARRANGEMENT RULES

Place equipment with the same letter code in the same vicinity, since they are used for the same type of work. The letter code provides an overall grouping, but much can be done within these groupings to make the shop easier to work in. Efficiency is the prime concern, so place equipment to save steps. Take advantage of natural window light in placing the equipment if space requirements can thereby also be met.

Do not overlap the equipment part of the template, since that represents the actual equipment. The operator space can be overlapped by workpiece space or other operator areas, if only one person is to work in the shop. It is preferable that this space be left free, however. Workpiece space can be freely overlapped by other workpiece space.

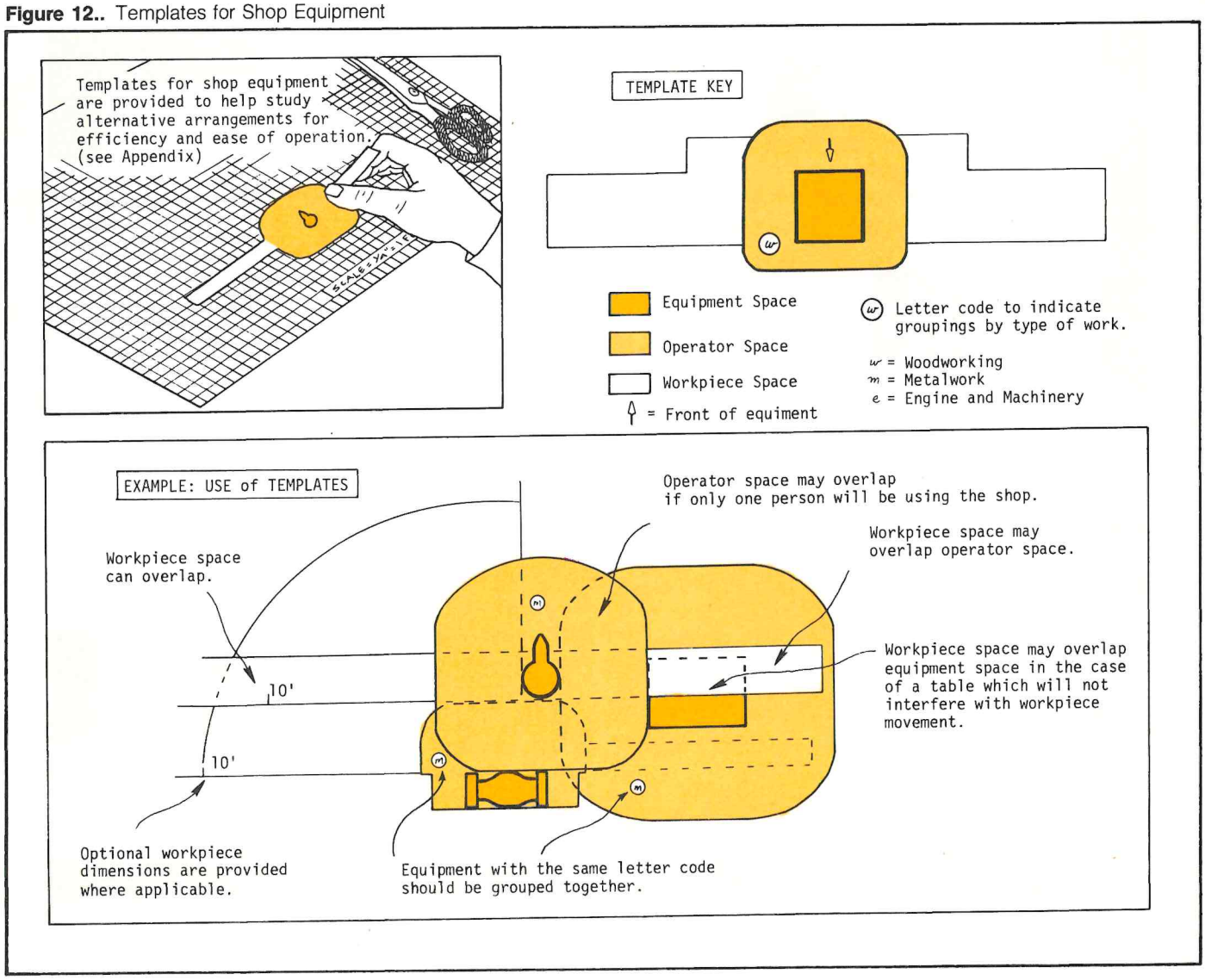
The workpiece size may be changed. Where applicable, the longest length likely to be used in a shop has been indicated. However, shop space may not allow the use of this length. To allow for this situation, templates are marked so they may be cut down to represent shorter lengths.

Location of electrical outlets should be noted in the plan. Overhead outlets can be planned or guarded floor cables installed in existing shops. If present outlets are not ideally located, it might be advisable to rewire. If they are used, equipment should be positioned accordingly.

To take advantage of limited space, special arrangements are possible. Some pieces of equipment such as table saws can be placed on casters so they can be moved into the general work area for use. Existing templates can be modified for special combinations, such as mounting the bench grinder so it can be swung below the bench when not in use.

Compromises will be necessary to meet the particular needs of each farm. What compromises may be made will,

Figure 12.. Templates for Shop Equipment



in part, depend on the supporting tools. For example, a portable grinder requires less area than the stationary grinder as it can be taken to large work. Although less desirable but sometimes necessary, a portable electric half-inch drill can reduce the workpiece area needed for the drill press. However, when standard lengths of pipe, structural steel, or wood are to be worked on, plan the work space needed for it when arranging equipment in the shop.

EQUIPMENT and AREA ARRANGEMENT

Service area. An implement or project under repair or construction is placed in this area. No template is provided for it as it will vary in size and shape with the size, structural limitations, and intended use of each shop. This area must abut the machinery door. Work areas are then grouped around this open area.

To determine the required size of your service area, measure the largest implement or vehicle that will be brought inside the building for work. Remember that, in winter, while all the work may need to be done inside, no shop can be large enough for the largest job imaginable. Cut a template (from graph paper with one-quarter inch squares) at the scale of ¼" = 1 foot, large enough to enclose the largest project with three feet clearance on all sides.

Workpiece space may be extended into the service area, with the realization that a machine parked there for work will interfere with such workpieces. However, it may be necessary to accept this inconvience in fitting the equipment into a reasonable sized structure.

Welders. The arc welding area and oxyacetylene area should be a part of the hot metal working area, but in such fashion that the electrode holder cannot reach the oxyacetylene tanks. The two welding groups have been given their own letter codes since welder and table are a natural unit. Due to the wide variation in arc welder sizes, it may be necessary to change the template size accordingly. The operator spaces for the welder and their tables should overlap so that welder settings may be conveniently made.

Place the arc welders so that cables can reach the far side of the service area, and so that it can reach an implement parked on the maintenance center apron. Since the oxyacetylene welder is portable, it can be moved to a job. Neither welder is safe to use near the woodworking area or any areas with combustibles.

Blacksmith's and machinist's vises. The workpiece space is determined for the longest likely piece of stock to be worked on, or 21 feet for pipe. The space allows the full length to be extended to one side, and half the length to the other.

Operator space is needed in front of and on the side of the vise to drill, bend and use a wrench on a piece clamped in the vise. More space is needed in back of the vise for hacksawing and filing.

This template may be superimposed upon a work bench. The vise is the only exception to the rule that equipment portions of templates may not be placed on another. However, this overlapping is not recommended. It is convenient to have a small vise on the bench, but a heavy vise, requiring the operator and workpiece space indicated interferes with other work and wastes bench space. A floor stand takes less shop space.

Pipe vise. In order to work at any point on a standard length of pipe, 21 feet must be allowed back of the pipe vise and 10½ feet in front of the vise. Threading two inch pipe determines the operator space required, as it takes considerable force, and the positions assumed by the operator to apply this force vary considerably. Locate the pipe vise convenient to pipe storage.

Grinders for heavy duty weld grinding. Grinder space requirements differ depending on the type of grinder. If a stationary grinder is the only grinder available for weld preparation, adequate workpiece space must be left for the largest piece likely to need grinding preparation. This may range up to the maximum stock lengths of 21 feet for pipe and 20 feet for structural steel shapes. In order to grind any point on the length, it is necessary to extend the piece its full length to one side and half its length in the other direction. In order to bevel the end at any angle, a quarter circle whose radius is the length of the longest piece and whose center is one of the tool rests is required. This amount of space may not be available in many shops, so the template may be cut to the 10 foot size marked. If there is no other way of preparing welds, such a reduction should not be made.

The operator space in front of the grinder is determined by the wheel or elbow location when the operator applies a firm two-handed grip on a piece to apply full weight for rapid stock removal. The grip changes during grinding so it is not necessary to extend the space to the side. The space on each side of the wheel cover and in front is required to open wheel guards and change wheels on a 12 inch grinder.

Bench grinder for tool fitting. The operator space requirement is almost identical to that needed for a heavy duty grinder, though the reason is slightly different. For precise grinding operations the operator hunches over slightly, and depending on stance, either the heel or buttocks requires the space indicated. Less clearance is required to change wheels because they are smaller.

Drill press. In order to drill at any point on a 21 foot length of pipe it is necessary to extend the full length to one side, and half the length to the other side. It is desirable to allow room for full stock lengths at the drill press, since it is the only way, in most farm shops, to drill precise holes. The existing shop structure may, in some cases, make it impossible. In such cases, the template can be cut to repre-

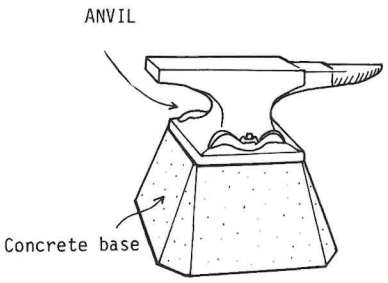
sent 10 foot lengths. The work piece space may overlap the space for a table because the drill press table can be raised above the height of the table.

The operator space is determined by three operations. Leaning over to observe or position work on the table, crouching to reach adjustment clamp under the table and raising or lowering the table. Thus, the difference in positioning of the table clamps between makes does not change the space needed. Since the space is measured from the chuck in front, the corners of the operator space are rounded in front, but this is not possible at the back corners as it is necessary to get at controls.

Anvils. It is particularly important that the anvil be located so that long pieces can be taken to it for forging. To reach any point on a piece it is necessary that the full length can be extended to one side, and the half length to the other. The workpiece space indicated for the anvil should not be reduced unless absolutely necessary.

The operator space on the sides is determined by the elbow or heel of an operator that stands well back from the anvil to avoid hot flakes of oxide that may be struck off while forging a hot piece. This measurement is made from the body of the anvil, so the corners are rounded. The space from the point of the horn allows ample room for the elbow while bending a piece over the horn, and the space at the other end allows room to work from the side on the hardy.

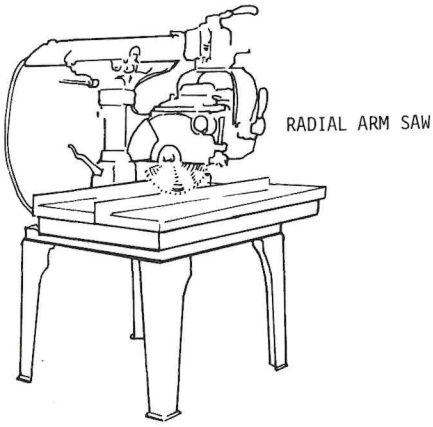
If a forge is used, place the anvil close to it so a piece can be taken from forge to anvil with less than a step. In this case operator spaces may overlap. Hang the blacksmith's tools so they can be reached without moving from the anvil. If the oxyacetylene welder or carbon arc torch are to be used for heating, locate the anvil convenient to the welding area.



Air compressors. No templates are provided for air compressors as sizes are so variable, only occasional access is required to a permanent compressor and a portable compressor merely requires a berth for storage. If stationary, the compressor may be mounted overhead, under a bench, or in similarly unused places. The compressor must be close enough to doors so that all four wheels of a 16 foot wagon on the front apron may be reached with the hose. Fifteen feet of hose will reach all four tires of a 16 foot wagon parked so one side is centered where the hose leaves the building. Add the distance from the compressor to door to this length. Use a ruler or a piece of thread fastened to a tack placed at the compressor location, cut one-quarter inch to the foot, to check hose length.

Table saw. Operator space must allow for free movement around the table edge and the operation of controls below the table. The work area specified for the table saw should not be reduced since it is often used to rip 16′ long lumber and saw 4′ × 8′ panels in either dimension. Some work space specified at the back of the saw will overlap with the space needed for a runoff table when one is used.

Radial arm saw. The workpiece area for the radial arm saw is determined by its principal use, cross cutting long pieces. The operator space is measured from the handle of the saw at the extent of its travel. Locate the radial arm and table saw convenient to the wood storage. Some work space specified at the left side of the saw will overlap with space needed for a lumber support table when one is used.



Woodworking vise. The space needed for a woodworking vise varies with mounting. The template shows the area needed if the vise is mounted at the end of the bench, which is the recommended method. The 8′ × 34″ area is needed to plane an eight foot long piece such as a door. Longer pieces will usually be taken to sawhorses. The space on each side of the vise and that behind the vise is needed for sawing either right or left handed. The woodworking vise template should be used in conjunction with the one for a work bench.

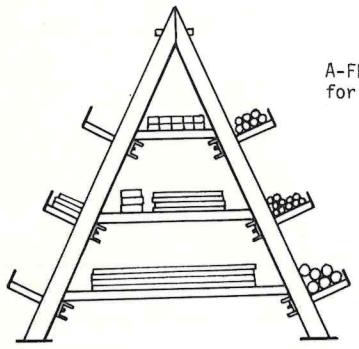
Work benches. The uses of work benches are so varied that space requirements must be generalized. Templates are provided for 6′, 8′ and 10′ long benches, 32″ wide. The use of bench surface is greatly restricted when a machinist vise or grinder is mounted on it. A wood vise may be mounted flush with the bench surface and close against the side without interfering with bench use.

Storage of Materials, Tools and Parts

Readily accessible storage for materials, supplies and parts is very important in making an efficient shop. Infrequently used materials, such as long lengths of steel and wood, may be placed in less used shop areas or in a machinery shelter. But storage for frequently used supplies, such as nuts, bolts, nails and screws, should be convenient to the work areas where needed and under good lighting. Little is more frustrating than trying to find a particular bolt in the semi-darkness of a back corner in the shop when an emergency repair demands immediate action.

Storage methods are so flexible that templates can only suggest ways of storing materials. The following guidelines will help in planning storage.

Storing long construction materials. An A-frame storage rack with arms or shelves for horizontal storage is usually best. The A-frame design provides a number of racks not only up each side, but also between sides. Wall racks might provide sufficient long storage space for some shop needs. It is easier to store 16′ or longer lumber and 20′ or 21′ steel and pipe horizontally—usually because the ceiling is not high enough to store such items vertically. Furthermore, it is dangerous to store heavy items vertically because sorting for a specific piece, could easily cause others to fall and injure someone.



A-FRAME STORAGE
for lumber and metal

Often long lumber is stored overhead on ceiling joists. Be careful not to stack lumber very high on the ceiling.

Classify items as much as is practical. For example, do not mix pipe with structural steel. Often used sizes should be separated from less used sizes. Do not mix lumber and steel as lumber is easily damaged by the steel.

Horizontal wood or metal storage templates are marked so they can be cut to two, three or four foot widths. The 36 inch area around them is recommended to remove material, particularly as a step ladder may be needed. Material in the wood rack will be removed to the side as boards do not slide well from a pile. If possible, allow room at one end of the metal rack, either a door or the general work area, so that full stock lengths may be slipped out one end without disarranging the other items.

Storing many small items. Nails, screws, bolts, washers, etc. are best stored in drawers. These items are difficult to find and scatter easily when stored on shelves. Separate items, such as nails and screws, by size. An assortment is useful only when the item is used occasionally and one has time to sort. Certain items, like bolts, may be grouped by size to save storage space and expense, particularly if each size is kept in its original container. A good drawer size is about 4½″ high, 5½″ wide and 11″ to 18″ long. It may be advantageous to compartmentalize some drawers.

Storing a few small and large items. Repair parts should be stored in a classified orderly manner. In many instances only one part is stored in a bin. Some parts can be grouped in a bin storage. Infrequently used, small tools can also be stored in bins. Other items that store well in bins are pipe fittings, electrical devices, soldering and welding supplies and small construction materials.

A variety of bin sizes will be needed. Bins that will hold most items are about 5 inches high by 9 to 12 inches deep by any width. Seldom does a bin need to be more than 10 inches high. Some supplies and parts, such as paint, pails, funnels, pans, etc. store well on shelves.

An occasional large and extra heavy part can be stored on the floor under a bench, but it doesn't take many of these items to clutter up the shop floor.

Short construction materials. Short pieces of steel pipe, conduit, wood, etc. can be stored on shelves of an A-frame storage unit. Some separation of materials can be achieved, depending on the number and length of the shelves.

Small, odd-shaped pieces of steel can be contained in barrels or carts built for this purpose. Sometimes though, it's a problem to find a piece to use.

Wide shelving is recommended to store sheet metal, plywood, etc. A wide work bench with a shelf below is a good place to store such items.

Items that can be hung. Many bulky items such as rolls of wire, rope, V-belts, hoses, rolls or tubing can best be stored on pegs, large nails, or specially built hangers on a wall. Tubing or hose should be hung on hangers, not on nails or pegs.

Welding electrodes. Arc welding electrodes are unuseable if their flux gets wet or oily. Some electrode fluxes will absorb enough moisture from the atmosphere to destroy their desired properties. E7018, a low hydrogen type electrode for welding medium carbon and low alloy steel, must be kept absolutely dry. Electrodes may be stored in an old refrigerator. The cooling unit is disconnected and a 25 to 40 watt light bulb is kept on to maintain a temperature between 100 to 150°F when the door is shut.

Cement. Even in new, tightly closed bags, cement absorbs moisture when set on a concrete or dirt floor. The bags should be stored on a slatted wooden floor if they are to be kept several months.

Green lumber. Green lumber must be allowed to air-dry slowly outdoors under an open sided shelter. Hardwoods, especially, will dry too fast and warp or check in a heated room where the humidity is too low.

Fuel. Fuel tanks should be buried, if possible, for both safety and to keep fuel temperature uniform. A uniform cool temperature reduces both fuel evaporation and accumulation of moisture. Any above ground tanks should be shaded and painted white to reduce evaporation losses. Pressure-vacuum caps reduce both the loss of fuel and also risk of fire from accumulated vapors in nearby buildings or depressions.

There is a tendency to store small quantities of gasoline, cleaning solvents and other flammable materials in cans throughout the shop. This practice is dangerous even when safety cans are used because they can easily be damaged or spilled as work goes on in the shop. An explosive mixture of fuel and air can easily be produced from gasoline spilled on the shop floor. It is strongly recommended that all highly flammable materials, grease and oil, be stored in a separate small shed designed for this purpose. If greases and oils must be stored in or near the shop work area, protect them from sparks, flames and extreme heat.

Office. All shops need a bench, desk or shelf to store, repair and service records and machinery manuals. A small, enclosed area at one corner of the shop is often reserved as an office.

A storage area for repair manuals and machinery manuals, as well as office space may be included in the shop plan.

HAND TOOLS

Hand tools must be stored within easy reach of their area of use. Since the most commonly accepted method of storage is hanging, either in a tool cabinet or on the wall or toolboard, no planning template need be used. However, a rectangular template marked, for example, "Blacksmith's tools" can be used to indicate the location of the tool storage.

Improperly stored tools are frequently damaged or lost. It is not possible to recommend a best way to store tools. However, the following tool storage illustrations provide useful ideas (Figures 13, 14, 15).

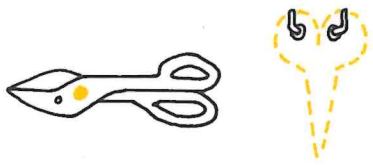
Durable tool hangers. The pictures show a variety of ways to hang tools, only a few of which can be purchased. Many are welded units. Wooden hangers may be made of hardwood for durability. Notice that all hangers are designed to hold a particular tool thus requiring that a tool be hung on the hanger made for it. The hangers shown will make possible the hanging of multiples of a type of tool in a space conserving manner.

Not only must the tool holder itself be durable, the board or backing on which it is mounted must also be strong enough to hold the hanger and the tool securely over a long period of rough use. A board to which a tool holder is to be fastened should be at least ¾ inch thick.

Group tools. Tools are much easier to find and return to storage when grouped according to major use. Provide a separate cabinet or storage board for each group of tools listed under Tools Specifications.

Color code tools. Paint the same color spot on each tool as is used to paint the inside of the cabinet or the board where the tool is to be stored. This system makes it easier to find the right storage place for each tool, especially when a number of tools have been taken from several places.

Color codes simplify tool replacement



Types of tool storage. A storage cabinet provides greater security and protection than an open wall or board. Also, tools can be kept in a smaller space. An open board or wall puts all the tools in good view; a well-planned cabinet can do almost as well. A roll-around or portable cabinet is very handy, for engine maintenance work done in several areas in the shop or outdoors. A portable cabinet does take extra floor space which may be limited.

Many hours of time and thought are necessary to provide good tool storage. Tools, however, are expensive, and so is the time wasted looking for them. Avoiding the frustration of looking for lost tools is a good reason to provide good storage.

Figure 13. Hanging Devices for Tools and Equipment

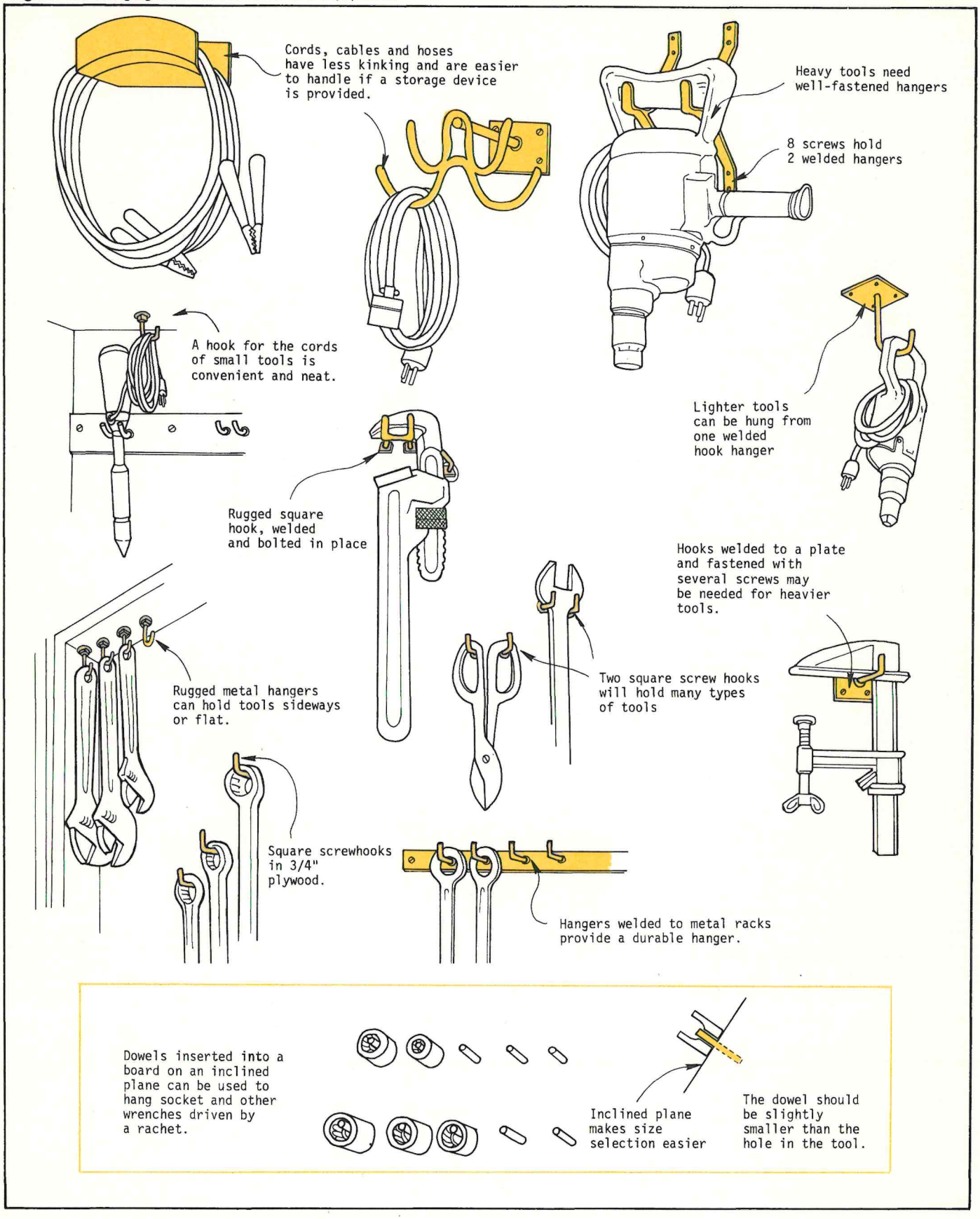


Figure 14. Protecting Sharp or Delicate Tools in Storage

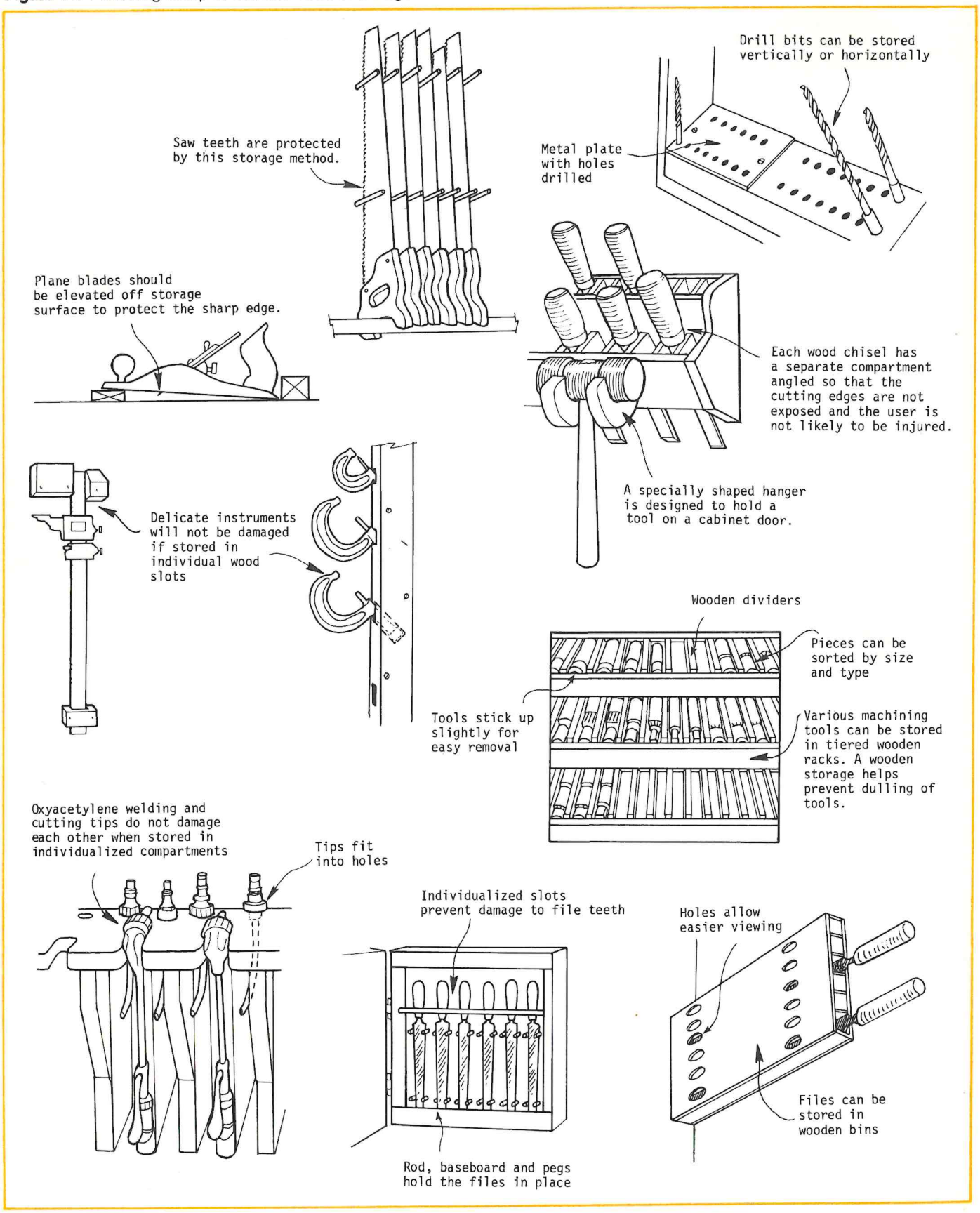


Figure 15. Specialized Storage Devices

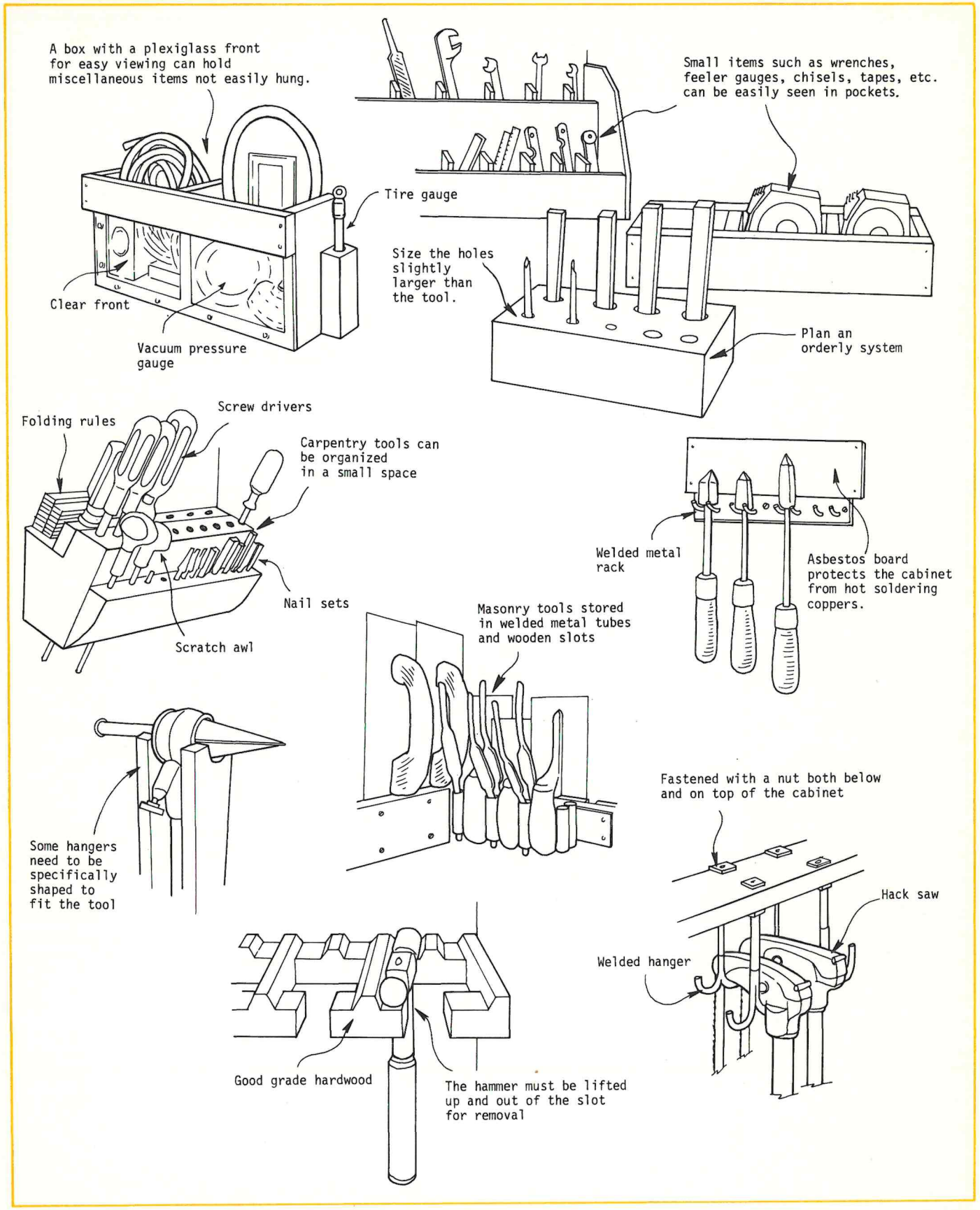
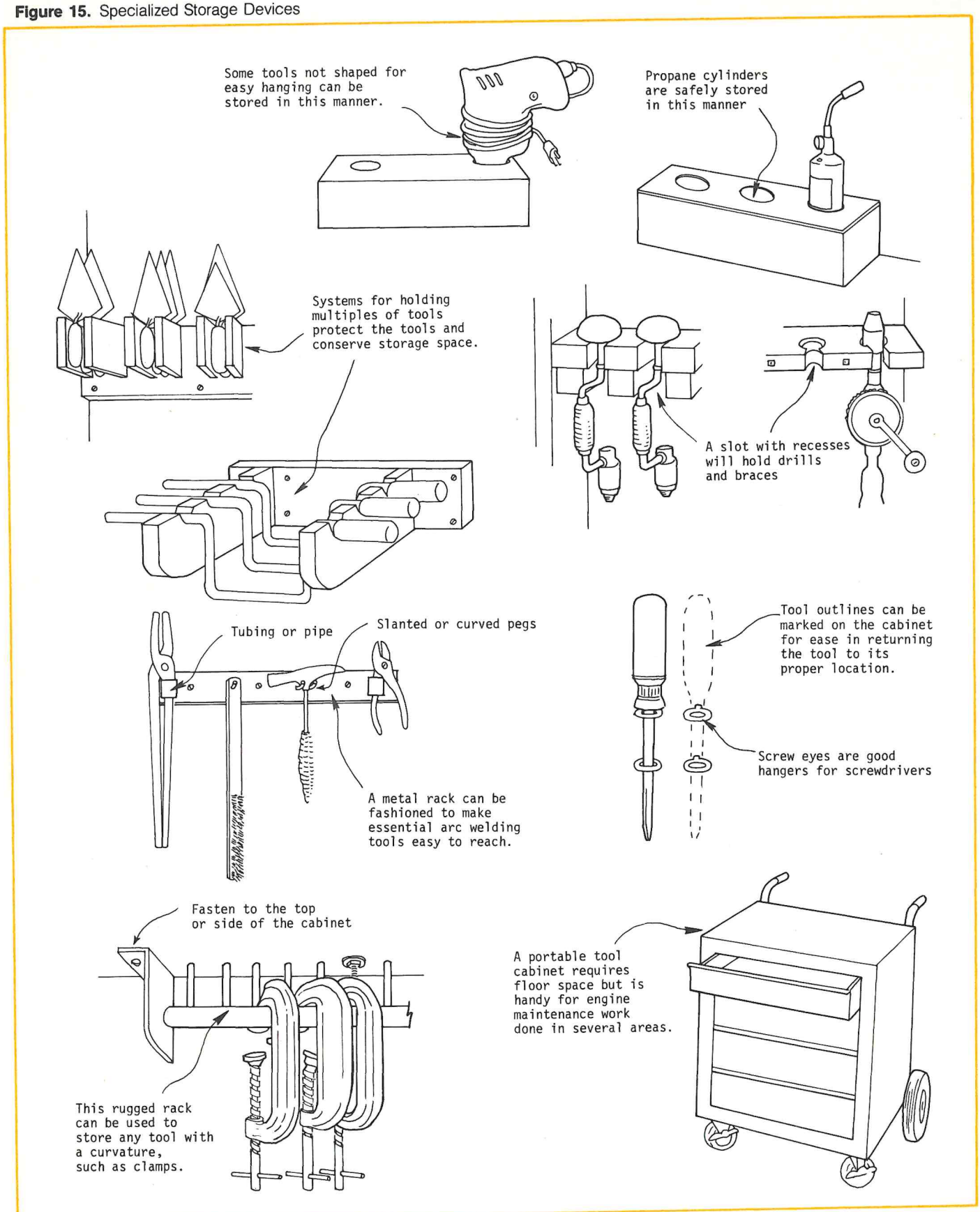


Figure 15. Specialized Storage Devices



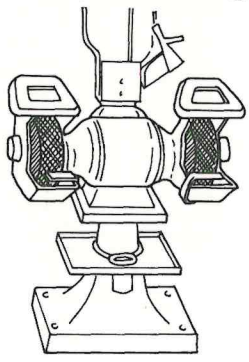
Equipment and Power Hand Tool Specifications

Carefully consider the specification requirements of equipment tools before a purchase is made. The specifications are a guide to selecting durable and long lasting equipment and power tools that will do a good job. Less costly equipment and tools can, of course, be purchased but they often do not give satisfactory service or life expectancy. Use only Underwriters Laboratory (UL) listed electrical equipment.

Bench grinder. Wheels should be at least 6 inches in diameter, 8 inches is preferable, by one inch wide. Vitreous bonded 60 to 100 aluminum oxide grit with K to N grades are most commonly used. A wire wheel is useful to interchange with a grinding wheel. An ½ to ¾ hp motor, running at approximately 3450 rpm on 120 or 240-volt power is needed. Sealed ball bearings, illuminated safety shields and sturdy, easily adjusted tool rests and wheel guards are essential.

Stationary heavy duty grinder. Wheels should be at least 10 to 12 inches in diameter by 1½ to 2 inches wide. Wheels of vitreous bonded, relatively coarse aluminum oxide grit, such as 24 to 40, of grades M to R, are recommended for heavy duty snag grinding. A finer grit and softer wheels are needed for more precise grinding such as sharpening mower sickles. A 1½ to 2 hp motor, turning at approximately 1750 rpm on 240 volt single or 3 phase power is needed. Sealed ball bearing, illuminated safety shields, sturdy, easily adjusted tool rests, and wheel guards are essential.

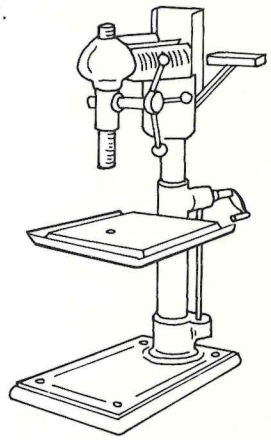
HEAVY DUTY GRINDER



Portable angle sander grinder. Spindle diameter should be ⅝ inch by 11 threads to hold either a 5 inch cup wheel or seven inch sanding discs. A 5000 no-load rpm motor with a 12 to 13 ampere rating at 115-125 volts is recommended. Motors which draw less than 12 amperes are not satisfactory for heavy duty use. A light weight, rugged aluminum case and sealed ball bearings are desirable. Grinding wheel manufacturers specify which wheel or sanding disc is best for a particular use.

Drill press. The drill press should have the capacity to drill a ½ inch hole in steel; a ¾ inch capacity will be needed in larger shops. A distance of 7½ to 8½ inches between the center of the post and the center of the drill is usually adequate. Spindle speeds should be easily adjustable within a range of 250 to 3000 rpm. The spindle should travel 5 to 6 inches and have a spring return. A ½ inch straight drill shank is recommended for shops in which a variety of small drilling jobs will be done. A ¾ hp or larger motor with sealed ball bearings is recommended. A drill press vise with jaws that open at least 6 inches is needed to do accurate work safely.

DRILL PRESS



Circular saw for wood. In most circumstances, the saw should be designed for heavy duty use. A 6½ inch diameter blade is the minimum size recommended; a 7¼ inch blade is recommended for large construction work. A heavy duty saw will use 10 to 12 amperes at 115-125 volts. The guard should pivot easily about the saw blade and return firmly to cover the blade when the cut has been completed. The motor should have sealed ball or needle bearings. The foot should be made of heavy-gauge steel, and be a rigid support at any angle. A hardened tooth, or carbide tipped combination blade is satisfactory for most jobs.

Sabre saw. The sabre saw should be designed for heavy-duty use. The gears should be housed in an aluminum case. The frame can be aluminum or glass fiber filled phenolic. A good saw will have an anti-vibration counterweight, sealed ball or needle bearings, a full one-inch stroke, a 2.5 to 4.5 amp variable speed motor, and a two-way tilting adjustable shoe. A variable or multispeed motor is needed to cut metals without overheating and breaking the blade.

Portable electric drill. Drills of two sizes, ¼ inch and ½ inch chuck capacity, are usually needed. Three-eighths inch size is also available; some may prefer it. They should be heavy duty, unless they will only be used for occasional light work. The ¼ inch drill should run at about 1800 rpm at no load and the ½ inch drill should have a chuck speed in the range of 400-550 rpm under load. Heavy duty, ¼ and ½ inch drills will be rated at 3 and 5 amperes respectively at 115-125 volts. Motors should have sealed ball or needle bearings contained within a rugged aluminum case.

Chain saw. A gasoline-powered, 16-inch heavy-duty saw is recommended for the more demanding cutting jobs. Smaller models are available but the engine is less powerful and the construction is not as rugged. Both automatic or manual oilers for bar and chain lubrication are satisfactory. Desirable features are: a heavy duty centrifugal clutch, reversible cutting bar, exhaust emission away from the operator through a quiet muffler, spark arrestor and external chain adjuster for simple chain tension adjustment.

Stationary power saws for wood. Both a table and radial arm may be needed in shops where a considerable amount of wood sawing is done, especially when cuts need to be precisely made. The table saw is more versatile as any kind of cut can be made on it; although it is not easy to make cross cuts on long lumber. The radial arm saw is best for cross cutting long pieces. A table saw should be large enough to use a 10-inch blade and a radial saw should use one 12 inches in diameter. A heavy duty blade and motor support arm of the radial arm saw is essential.

A table saw that has a tilting arbor (blade tilts) is better for accurate and safe sawing than one that has a tilting table. Less costly saws do not have a sturdy enough ripping fence.

A safety shield, splitter and anti-kickback fingers are essential. A large (approximately 27" × 36") cast iron table with tee slots in which a tee mitre slide fits is desirable. Either saw needs a 1½ hp (min.), 115/230 volt single phase, 3450 rpm capacitor motor with sealed ball bearings. Either a combination or a safety blade, preferably carbide tipped, is best for most work.

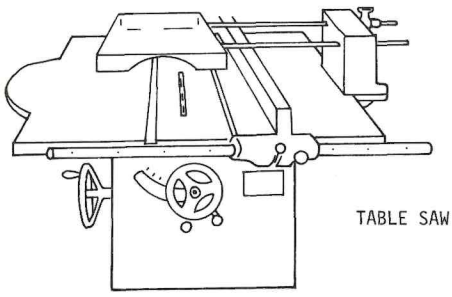
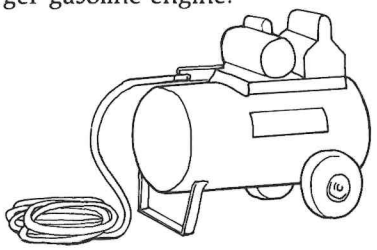


TABLE SAW

Stationary air compressor. A single stage compressor with a delivery capacity of no less than 3 cubic feet per minute (scfm) is the smallest size to consider. Some shops may need a delivery capacity of up to 10 scfm, especially if spray painting is to be done. The maximum output pressure should be no less than 125 psi. If there is need for higher air pressure, the compressor must be a two-stage unit which develops up to 175 psi pressure. The delivery capacity must equal the air volume requirements for all devices that the compressor will operate at the same time plus an additional 25%. A pressure switch control is best for light or intermittent duty because it saves power and reduces wear. Use a constant speed unloader which keeps the compressor running continuously for heavy use. The size of motor needed is determined by the size of the compressor. A ½ hp repulsion induction motor is the smallest recommended. Twenty-five feet of air hose is usually enough. The tank should have at least a 20 gallon capacity.

A portable air compressor is often more useful in a farm shop than a stationary one. Such a unit is powered by a 3 hp or larger gasoline engine.



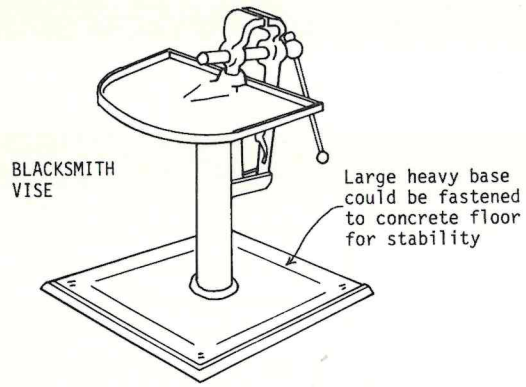
PORTABLE
AIR COMPRESSOR

Paint spray gun. A paint gun that uses about 2.5 to 6 cfm of air at 30 to 50 psi is satisfactory for most home, shop and light production work. The bleeder-type sprayer must be used with small compressors which have no unloading mechanism. The non-bleeder type gun is needed for fine regulated tank or air line systems. External mix guns are used for fast drying and heavy paints. An external mix, non-bleeder type gun is needed for fine automotive or industrial-type finishing. A small bleeder-type gun can be operated with a small ½ hp piston type compressor which delivers the volume and pressure of air specified above.

Chain hoist. A one or two ton capacity hoist hung from either a beam or a portable floor crane is most practical for farm use. Either a differential or gear-drive hoist is satisfactory for occasional use; and they are considerably less expensive than electric or air powered hoists. The portable unit can be moved to the job, however, it does take up floor space. An overhead beam-mounted hoist is out of the way, but more expensive. Placement on a track permits moving an engine or machine part near a wall for service. However, the roof structure must be designed to carry the load lifted by the hoist.

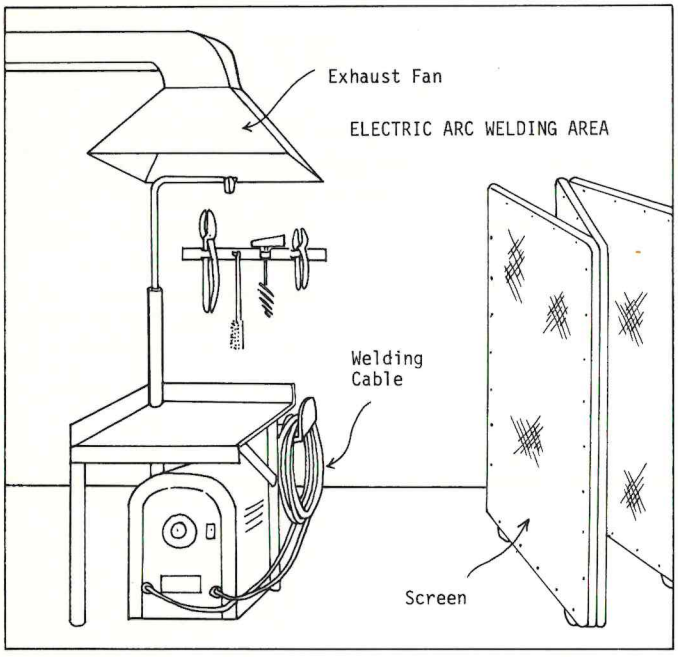
Battery charger. The intended use of a charger determines the type needed. A small 4 to 6 ampere charger will put a slow charge in a battery. If a charger is to be used to start an engine with a run-down battery, it must have 30 ampere fast charge and 200 or higher boost charge capacities.

Blacksmith vise. When heavy hammering is to be done on objects held in a vise, a heavy-duty blacksmith vise with 6" wide jaws is needed. It must be mounted on a heavy stand or on a ruggedly built table.



Hydraulic jack. A portable, floor jack with a capacity of at least 3 tons is recommended; 5 tons is needed for some farm jobs.

Electric arc welder. Most home and farm electric arc welding jobs can be performed with an alternating current (AC) machine with a maximum welding current output of at least 180 amperes. The machine must have a secondary open circuit voltage output of 75 to 80. A 20 percent duty cycle rating at maximum amperage output is satisfactory if the rating at or near 100 ampere output is 100 percent. A built-in capacitor (power factor correction) is usually no longer required by the power supplier, but check before buying. When a large welder is desired, it is often cheaper to buy a power factor corrected one because smaller branch circuit wire can be used.

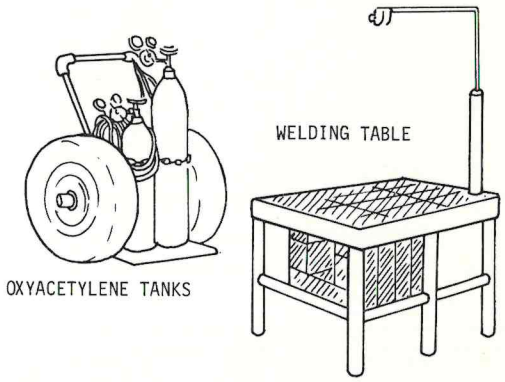


Welding cables should be up to 25 feet long. If a longer reach is necessary, the welder lead-in cable should be replaced with a longer one. Lengthening this cable will cause less voltage drop for welding than lengthening the welding cables. Some electrode holders or ground clamps are poor, so be sure to obtain a good quality, well-insulated, repairable holder and a strong ground clamp that makes a good contact with the work. Also purchase a good helmet with a flip-up lens that covers a clear lens for eye protection while chipping. Most welders prefer a shade 10 lens. The cover lens should be spatter proof plastic.

If an oxyacetylene torch is not available, a twin carbon arc torch is good for braze welding and heating.

Oxyacetylene welder. A medium-sized welding outfit with cutting attachment and readily available replacement parts is preferred. At least four sizes of welding tips are needed. Buy the smallest tip or the next larger one and alternate by larger sizes. An equal-pressure torch, rather than an injector torch is the best choice for farm use. Tips that have individual mixers are easiest to use. Two sizes of cutting tips will do most jobs; one for cutting ¼-inch thick steel, the other for thicker. High quality single stage, adjustable regulators are satisfactory. Do not purchase economy models as they do not give satisfactory service.

Demurrage charges for tanks can usually be handled best with a lease agreement. Generally a 244 cubic foot oxygen tank and a 100 cubic foot acetylene tank are sufficient. A smaller oxygen tank is better when the equipment is only used occasionally. A cart to carry and secure the tanks for safe handling and 15 to 20 feet of 3/16-inch twin hose, will enable the welder to reach any job. Goggles or a face shield with a #4 or #5 shade is preferred.



High pressure washer. A high pressure washer should deliver a minimum of 1.8 gallons of water per minute at 500 to 550 psi. Washers that deliver up to 4 gallons per minute at 1000 psi are recommended for consistent, heavy duty cleaning. The washer should be designed to use hot water, up to 140°F, and to automatically mix detergent with an outside water supply. Nozzles are made to spray at a variety of angles. A 15° nozzle is best for stripping or cutting through heavy grease, mud, etc. A twin or 3-cylinder, positive displacement pump is recommended.

Hand Tool Specifications

It is difficult to specify the exact tools that will be needed in every farm shop. The list which follows is intended only as a guide. Listed by areas are tools basic to the work involved, if fairly extensive work will be done. Many of the tools listed under the following headings will be used in several work areas. Some of these tools will need to be duplicated to carry on machines. If only one type of work is to be done, some tools listed for other jobs also will be needed.

Along with choosing the kinds of tools, give major consideration to tool quality. Although it is not always necessary to purchase the best tool available, one of poor quality and incorrect specifications is likely to be unsatisfactory. Poor tools discourage doing work that should be enjoyable and profitable.

Carpentry Tools for Maintenance and Construction

Number	Tools and Specifications
1	Auger bit brace, racket type, 10-inch sweep
1 set	Auger bits, 1/4 to 1 inch by 16ths
1	Expansive bit, 7/8 to 3 inches
1	Countersink, rose type
4	Screw drivers, standard tip (listed under Engine Mechanic's Tools)
1 set of 6	Wood chisels, sizes 1/4 to 1 1/2 inches
2	Bar clamps, adjustable, 12-inch opening
1	Glass cutter
1	Claw hammer, 16 oz.
1	Half hatchet
2	Saw horses, homemade
1	Putty knife, 1 1/4-inch wide blade
1	Caulking gun, cartridge load
1	Carpenter's level, 24 inches long
1	Oil stone, combination of coarse and fine grits
1	Jack or smooth plane
2	Steel tapes, 10 and 100 feet long
1	Crosscut saw, 8 point, 26 inches long
1	Half round wood rasp, 12 inches long
1	Carpenter's rafter square
1	Combination square, 12 inches long
1	Woodworker's vise, 4 x 7-inch or larger jaws
1	Auger bit file
1	Push drill with set of 8 drill points 1/16 to 11/64 inches
1	Chalk line, 100 feet

Sheet Metal Tools for Maintenance and Construction

Number	Tools and Specifications
1	Electric soldering copper, 300 to 500 watt
1	Propane torch with pencil and utility tips
1	Plastic faced mallet, 16 oz.
1	Tinner's hammer, 12 oz.
1	Hand seamer, 3 1/2-inch wide blade
5	Rivet sets, sizes 0, 1, 2, 5, and 7
1 pair	Tin snips, regular pattern 12 inches long
1	Steel rule, 4 feet long
1	Scratch awl
1	Prick punch, 5 or 6 inch
1	Sheet metal punch, 3/32 to 9/32-inch punches and dies
1	Blind riveting tool, 1/8 to 3/16-inch capacity
1 pair	Locking sheet metal workers' tool, 8 inches long (Vise grip®, or equivalent)

Engine Mechanic's Tools for Major Overhaul Work

Number	Tools and Specifications
1 set of 4	Small hole gauges, .125 to .500-inch range
1 set of 3	Telescopic gauges, .500 to 2.125-inch range
1	Tube flaring tool, tubing sizes 3/16 to 5/8 inches
1 set	Tappet wrenches, sizes 7/16 to 7/8 inches
1	Valve spring compressor, heavy duty C-type
1	Compression gauge with adapters
1 set	Inside micrometers, 2 to 8-inch range
1 set of 6	Outside micrometers, 0 to 1 inch, 1 to 2 inch, 2 to 3 inch, 3 to 4 inch, 4 to 5 inch, and 5 to 6 inch
1	Torque wrench, 175-foot pound, 1/2-inch square drive
1	Tube cutter and reamer, tubing sizes 1/8 to 1 inch
1	Ring compressor, 2-1/8 to 5 inch capacity
1	Carbon scraper
1	Torque wrench, 300 inch pound,3/8-inch square drive
1	Radiator pressure tester
1	Parts cleaning brush
1	Piston ring spreader

Engine Mechanic's Maintenance Tools

Number	Tools and Specifications
4	Screw drivers, standard tip, sizes 3/16, 1/4, 5/16 and 3/8 inch wide
4	Screw drivers, Phillips point, sizes 1, 2, 3, and 4
1	Tire gauge, truck, 1 to 160 psi and/or air-liquid 10 to 50 psi
1	Screw driver, stubby, 1/4-inch wide standard tip
1 set of 5	Screw extractors, 3/16 to 3/4-inch screw capacity
3	Ball peen hammers, 8, 16, and 24 oz.
1	Trouble lamp
2 pair	Combination pliers 6 and 8 inches
1 pair	Diagonal cutting pliers, 6 or 7 inch
1 pair	Long nose pliers, 6 inch
1 pair	Ignition pliers, 5 inch
1 set	Box end wrenches, 15° offset, sizes 1/4 to 1 inch by 16ths
1 set	Open end wrenches, 15° angle, sizes 1/4 to 1 inch by 16ths
1 set of 4	Ignition wrenches, sizes 3/16 to 11/32 inch
1 set	Socket wrenches with ratchet handle and extension, 1/2 inch square drive, 12 point, sizes 1/2 to 1 inch by 16ths
1 set	Box end wrenches, 15° offset, sizes 11 to 32 mm by mm
1 set	Open end wrenches, 15° offset, sizes 6 to 24 mm by mm
1 set	Socket wrenches, 1/2 inch square drive, 12 point, sizes 10 to 27 mm by mm.
1 set	Socket wrenches with ratchet handle and extension, 3/8 inch square drive 12 point, sizes 1/4 to 9/16 inch by 16ths
1	Battery Hydrometer
1	Battery strap
1	Mechanic's creeper
1 set	Spark plug gauges
1 set	Thickness gauges, sizes 001 to .025 inch by thousands
1 pair	Rib groove adjustable pliers, 9 inches long (Channellock®, or equivalent)
1	Timing light, inductive pickup type
3	Spark plug sockets, 5/8, 13/16, and 7/8 inch 1/2 or 3/8 inch square drive
1	Hydraulic jack, 5 ton
1	Battery terminal tool
1	Battery clamp puller
1	Battery filler
1 set of 3 of 4	Funnels
1	Oil filter wrench
1	Oil measure, 2 quart size
1	Oil spout
1	Oil drain pan
1	Tire tool hammer
1 set	Nut drivers, sizes 1/4 to 3/8 inch by 1/32 nds
1	Tach-dwell meter
1	Circuit tester, 2 to 18 volts DC

Tools for Hot and Cold Metal Working (not including welding)

Number	Tools and Specifications
1 set	Twist drills, high speed, sizes 1/16 to 1/2 inch by 32nds, straight shank
4	Twist drills, high speed, sizes 9/16, 5/8, 3/4, and 1 inch, 1/2-inch straight shank
5	Cold chisels, sizes 1/4, 3/8, 1/2, 3/4, and 1 inch
1	Grinding wheel dresser
1	Screw plate set, NC and NF taps and dies, sizes 1/4 to 3/4 inch by 16ths
1	Center punch, 3/8-inch shank
1	Hand hacksaw, 12-inches long heavy duty frame, 18 or 24-pitch blade
3	Mill files, bastard cut, sizes 8, 10, and 14 inch
3	Machinist's files, half round, bastard cut sizes 8, 10, and 14 inch
3	Machinist's files, round bastard cut, sizes 5/16, 3/8, and 1/2 inch
1	File card
1	Steel square, 8 x 12 inches
2	Blacksmith hammers, cross peen, sizes 2 and 3 pound
2 pair	Blacksmith bolt tongs, sizes 3/8 and 1/2 inch
2 pair	Blacksmith straight lipped tongs, 1/4 and 3/8-inch capacity
1	Machinist's vise, heavy duty, 4 to 4 1/2-inch wide replaceable steel jaws
1	Blacksmith anvil, 150 to 200 pounds with tool steel facing and a 2-inch wide hardie

Farm Machinery Repair Tools

Number	Tools and Specifications
1 set of 5	Gear and wheel pullers, 3 to 7-inch spread
3	Punches, long taper, sizes 3/16, 1/4 and 3/8-inch point
1	Leather punch, revolving head with 6 tubes
7	Pin punches sizes 3/32, 1/8, 5/32, 3/16, 7/32, 1/4, and 5/16 inch
4	Adjustable wrenches, sizes 6, 8, 10 and 12 inch
1 set	L shape hex key wrenches
2	Pipe taps, sizes 1/8 to 1/4 inch
1	Locking plier - wrench, 8 inches long (Vise grip®, or equivalent)

Welding Tools (not part of welder)

Number	Tools and Specifications
8	C clamps, two each of sizes 3, 4, 8, and 10 inch
1 pair	C clamp, 11 inches long (Vise grip®, or equivalent)
1 pair	Welding clamp, 9 inches long (Vise grip®, or equivalent)
1	Chipping hammer
1	Wire brush
1 set	Welding tip cleaners

Plumbing Tools for Maintenance and Installation

Number	Tools and Specifications
1	Pipe cutter, heavy duty, 1/8 to 2-inch pipe
1	Pipe threader, sizes 1/8 to 2-inch pipe
1	Pipe reamer, sizes 1/8 to 2-inch pipe
3	Pipe wrenches, sizes 12, 18, and 24 inches
1	Pipe vise on stand, 1/8 to 2 1/2-inch pipe
1	Air acetylene, Mapp or propane torch kit, multiflame

Electrician's Tools for Maintenance and Installation

Number	Tools and Specifications
2	Electrician's screw drivers, sizes, 3/16-inch wide by 4 inch long and 1/4 inch wide by 6 inch long blades, insulated handles
1 pair	Lineman's pliers, 8 inches long
1 pair	Round nosed pliers, 6 inches long
1	Circuit tester, 80 to 500 volt, AC/DC
1	Combination clamp-on ammeter, voltmeter, and ohmmeter, 300 amperes, 600 volts
1 pair	Wire stripping and crimping pliers
1	Soldering gun, 240/325 W

Miscellaneous Tools and other items

Number	Tools and Specifications
1	Crow and tamping bar, 5 1/2 feet
1	Ripping bar, 24 inch
1	Gasoline can, 5 gallon
1	Pump oiler, 1 pint capacity
1	Log chain, 5/16 inch, 12 to 16 feet long
1	Grease gun, lever type, bulk or cartridge loaded
1	Sledge hammer, 6 to 8 pound
1	Fence stretcher or portable puller
1	Extension cord, 25 feet, number 16, 3-wire conductor
1	Bolt cutter, 1/2-inch medium hard rod capacity
1 pair	Safety shield or goggles

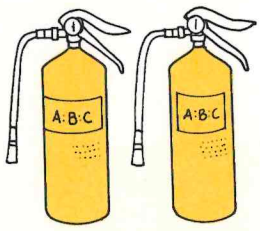
Tools for Concrete Work

Number	Tools and Specifications
4	Masonry drills, sizes 1/4, 3/8, 1/2, and 5/8 inch
1	Jointer 3/8 x 1/2 inch
1	Concrete edger, round corner, 2 1/2-inch wide x 6-inch long blade
1	Bull float
1	Bricklayer's trowel, 9 to 11 inches long
1	Concrete finishing trowel, 12 to 14 inches long x 4 inches wide

Shop Safety

Fire fighting equipment. A garden hose with nozzle attached to a water system is one of the best fire extinguishers for wood, farm forages, and other cellulose products. The water supply should maintain at least 20 pounds, 50 psi is better, pressure at the nozzle with water flowing. At least a ¾ inch diameter, 50 foot long hose is needed to wash equipment standing outside the shop. The faucet should be close to the large outside door.

Place a multi-purpose dry chemical (A:B:C) extinguisher near entrance doors and welding areas. This tri-class extinguisher will extinguish wood and hay fires as well as oil and grease fires. Do not use water on oil or grease fires, since it can spread this type of fire.



Fire extinguishers should be readily accessible near entrance doors and welding areas.

Protective clothing and equipment. Work gloves, with leather fingers and palms, are needed to handle rough iron and lumber. Heavy shoes, preferably the "safety" type with metal toe caps and wire mesh in the soles, are appropriate for many types of farm work. More farmers are also now using safety hats when working in the woods.

Hard finish denims are good base clothing for shop work. For arc welding, full skin covering is needed to prevent radiation burns as well as heat burns from sparks and flying hot metal. Cuffs on pants are dangerous; they both catch on objects and hold hot pieces of cut off metal or flying sparks. Keep flammable materials out of pockets, particularly matches and cigarette lighters.

Shop maintenance. The storing, or holding, of waste oil, wood scraps and shavings, scrap metal, oily rags, etc. presents both fire and accident hazards. Wood scraps, shavings, and even oily rags may be used to start and fuel a wood heater; and it eliminates that waste. Used oil, odds and ends of paint, cleaning fluid, etc. pose a high fire risk; they should be stored in closed containers and, for most rural areas, be placed in a sanitary land fill.

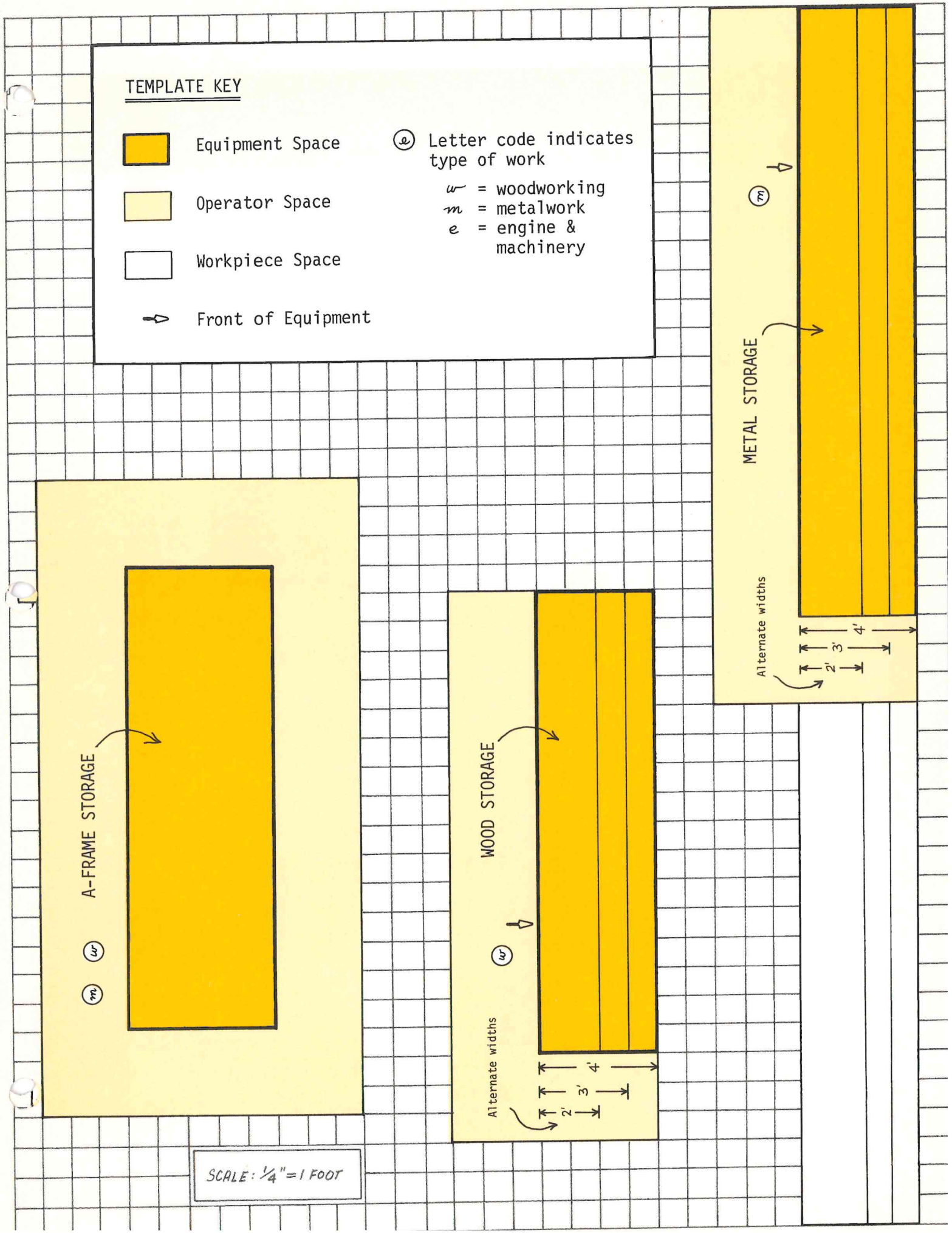
Wipe up or absorb spilled oil or grease; these spills are dangerously slippery. Grease and oil spills, if small, can be wiped up with cloth rags. For larger spills, sawdust, trade name absorbents and cat litter work well. More and more shops use an industrial vacuum cleaner for both wet and dry spills.

Be sure that anyone using the shop can easily identify an unsafe, dull, or incomplete tool or machine. For example a power saw with a dull blade or a gas welding outfit with a defective gauge should be tagged or otherwise identified as out-of-order.

Maintain all equipment in good condition, particularly cutting tools. Dull tools glance off, bind, or otherwise cause trouble. Maintain tool handles and faces, proper chain and belt tension, guards in place, electric cords in good shape, and no burrs on chisels. Have a place to hold guards when they must be removed. Have a face shield and/or goggles hanging close by power equipment. Inadequate lighting may cause an accident.

First aid supplies. Keep a first aid kit handy for minor cuts, abrasions and burns. Place an eye wash near the entrance or where caustic chemicals are used.

Security. Install locks to secure the shop and particular areas within the shop. At least one all-night, automatically controlled, security light on a pole or buiding is needed to light the central farmstead. Hazardous materials like pesticides, dynamite, etc. must be kept in a locked storage cabinet or room.


TEMPLATE KEY
Equipment Space
Operator Space
Workpiece Space
Front of Equipment
(e) Letter code indicates type of work
w = woodworking
m = metalwork
e = engine & machinery
METAL STORAGE
(m)
Alternate widths
2'
3'
4'
WOOD STORAGE
(w)
Alternate widths
2'
3'
4'
A-FRAME STORAGE
(w)
(m)
SCALE: 1/4" = 1 FOOT

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