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The Farm Freezing Plant

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THE facilities here provided are adequate for the farm storage of all fruits, vegetables, and meats and can be maintained at the proper temperature. Such a temperature, according to publications of the Federal Department of Agriculture (MC-53) and the Oregon Agricultural Experiment Station, should be established at a maximum of 0° F. Under no circumstances should fruit, vegetables, or meats be stored at a temperature above this point. Freezing can be done advantageously, however, at temperatures below this point. This not only speeds up the process but also improves the quality of the frozen material. The Food Industries Department of Oregon State College will furnish information on food freezing processes on request.

The following Oregon State College publications on the freezing of meat, poultry, eggs, fruits, and vegetables can be obtained from all Oregon County Agricultural or Home Demonstration Agents, or by writing to Oregon State College, Corvallis, Oregon:

Freezing Fruits, Vegetables, and Meats. Extension Circular 366, by E. H. Wiegand, Food Industries Department.

Freezing and Storing of Meat, Poultry, and Eggs. Extension Circular 373, by A. W. Oliver, Animal Husbandry Department.

The Farm Freezing Plant

by

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INTRODUCTION

The preservation of meat, vegetables, and fruit by freezing for later use by the family is a common practice in the Pacific Northwest. Probably no area in the United States has such an extensive freezer locker rental service. These large freezer locker plants are owned and operated privately, or as cooperatives, usually in connection with a creamery or retail meat market.

This freezer locker rental service has developed a desire for individual freezers that would eliminate the need of taking meat, fruits, and vegetables to and from the community freezer plant. The rapid extension of electrical service to farms in Oregon aids in making such a plan feasible. This idea is entirely practical from a construction and engineering standpoint, but must be studied by the individual to determine the feasibility of such a unit from the standpoint of convenience and costs as compared to the use of other facilities for freezing foods for home use.

Several types of facilities are listed here for the consideration of the person who wishes to study the possibility of installing a freezer plant for family food preservation:

1. Use a rental locker plant entirely with no farm refrigerator.
2. Use a rental locker plant with a standard household refrigerator.
3. Use a rental locker plant with a household refrigerator having a 1- to 6-cubic-foot freezer compartment or a separate 6-cubic-foot freezer refrigerator.
4. Use a large chest-type farm freezer and rent space to chill and age meat before freezing.
5. Use a 2-compartment farm freezer plant with both 0° and 35° F. storage.

The first method listed involves no investment in equipment but much inconvenience due to required frequent trips to the locker plant, and the lack of refrigeration to hold small quantities of frozen food at home.

The second plan, which can easily be expanded into the third plan, will serve the needs of most farm families at the minimum cost for good service. Some of the later models of household refrigerators have large freezer compartments. Also 6-cubic-foot special 0° refrigerators are available for less than $200.00.

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The fourth plan using the large chest-type farm freezer without 35° F. room does not provide adequately for chilling and aging meat before freezing, although it meets the requirements for freezing fruits and vegetables. The investment will be substantial, but less than for the 2-compartment complete farm freezer plant.

The fifth plan involves an investment of about $600.00 if the carpenter work is done by the owner. The operation will require about 100 kilowatt hours of electricity per month, which would probably cost $2.00. This plan provides a 35° F. room for chilling and aging meats, chilling fruits, vegetables, and cream, and a side-opening freezer compartment. This plan is particularly adapted to needs of the larger family that can use large quantities of frozen farm-produced fruits, meats, and vegetables, or the farm family located somewhat distant from a freezer rental locker.

Individual farm freezer plants of this type are in use on farms in Oregon and Washington and are giving good service when properly constructed.

A refrigerator plant that meets the demands in most cases has about 40 or 50 cubic feet of space held at 0° F., and another space having a volume of 150 to 200 cubic feet held at about 35° F.

Access to the low-temperature or freezer space is commonly through the 35° or cooler compartment. The low-temperature or freezer space is in the nature of a reach-in compartment or cabinet. Both top-opening and side-opening freezers have been used and each has its advantages. In the design submitted in this circular a side-opening compartment is shown because the greater accessibility of stored food, larger shelf area, and more efficient use of space are thought to have value sufficient to offset possible larger losses of refrigeration due to opening the door of the freezer compartment. A modification for more rapid freezing is to install part of the cooling surface in the form of a shelf on which the products to be frozen are placed. Another modification, which is adapted to either the top-opening or the side-opening freezer, is to provide a smaller compartment within the low-temperature space primarily for rapid freezing. By placing a large amount of refrigerating surface in this small compartment, somewhat lower temperatures, probably 15° to 20° below 0° F., can be obtained and more rapid freezing accomplished.* The additional cost of this compartment should not exceed $25.00.

In either of these cases the coil surface that forms the shelf should be protected to avoid puncturing or other damage when removing products that have frozen to the shelf. A heavy sheet metal about 16 gage is recommended to be used as shelf surface.

A refrigeration unit requiring a $\frac{3}{4}$-horsepower motor is necessary for a 50-cubic-foot 0° compartment and 150- to 200-cubic-foot 35° room with proper room construction and coiling. Such a unit has sufficient capacity to care for the normal refrigeration losses due to heat leakage and air changes, and in addition to cool 500 pounds of beef to 35° F. in about 12 hours or to freeze 50 pounds of beef in 16 hours. Not more than 50 pounds of meat or equivalent should be placed in the freezer compartment in any 16-hour period as slow freezing and lowered quality will result. The meat being chilled and aged in the 35° F. room should be cut and wrapped in waxed paper only as required for the freezer.

In the plans illustrated with this circular the maximum refrigeration capacity required in the freezing compartment is about 1,300 Btu per hour. This

* Further information on the construction of this special low-temperature freezing compartment can be obtained from the Agricultural Engineering Department, Oregon State College.

allows for: (1) heat leakage through the walls, (2) air changes due to door openings, and (3) freezing of 50 pounds of beef or equivalent in 16 hours. The maximum capacity required in the cooler is about 2,050 Btu per hour. This provides for: (1) heat leakage through the walls, (2) air leakages due to door openings, and (3) cooling of 500 pounds of beef or equivalent from 70° to 35° F. in 16 hours. The capacity of a ¾-horsepower refrigeration unit under the operating conditions indicated above is about 3,000 Btu per hour, which is ample since the maximum load on both compartments is unlikely to occur simultaneously.

INSULATION

Many insulating materials are available. Because of their cheapness and availability in many localities in Oregon, kiln-dried planer shavings are quite commonly used in commercial installations and when properly installed are very effective. Since the structural parts of the wall are the most expensive, it is evident that a wall 12 inches thick is not much more costly than one 8 or 10 inches thick. It is recommended, therefore, that when planer shavings are used the insulation for the 35° room be 12 inches thick, and for the 0° compartment 18 inches thick.* When more expensive insulating materials such as mineral wool, fiber glass, redwood bark fiber, or firtex are used, thinner walls are sufficient because of their higher insulation value. A comparison of the leakage losses for certain thicknesses of some of these materials is given in Table 1.

Table 1. COMPARISON OF REFRIGERATION LOSSES*

Insulation	Btu/Sq. Ft., Hr., Deg./In.	Thickness	Leakage per hour	Air change per hour	Total per hour
		Inches	*Btu*	*Btu*	*Btu*
35° *room,† inside dimensions* 4' x 5' x 6½'					
1 Dry shavings	0.4	12	285	200	485
2 Mineral wool or fiber-glass	.3	6	305	200	505
3 Redwood bark or balsam wool	.26	5	310	200	510
4 Firtex (five 1" sheets, ¼" air space between)	.34	5½	290	200	490
0° *room,† inside dimensions* 2' x 4' x 5½'					
1 Dry shavings	0.4	18	250	120	370
2 Mineral wool or fiber-glass	.3	9	250	120	370
3 Redwood bark or balsam wool	.26	8	220	120	340
4 Firtex (six 1" sheets, ¼" air space between)	.34	7¼	280	120	400

VAPOR BARRIER

One of the most serious problems in connection with effectiveness of insulation is keeping the insulation dry. Moist insulation is almost worthless.

* Ordinary sawdust is very inferior to dry planer shavings, but a sawdust sifted and treated especially for insulation purposes such as "Flakewood" can be used instead of planer shavings with excellent results.

* Approximately 2,050 Btu per hour are required to cool 500 pounds of beef or equivalent from 70° F. to 35° F. in 16 hours in addition to room losses.

† Approximately 430 Btu per hour are required to freeze 50 pounds of beef or equivalent in 16 hours in addition to room losses.

The principal source of moisture is vapor in the air. Vapor from the atmosphere tends to flow through a wall from the warm to the cold side, and as its temperature is reduced it condenses and the resulting water collects in the insulation. For this reason the wall should be made vapor tight near the outside surface.

In order to prevent infiltration of vapor from the air into the insulation, a vapor-tight seal must be provided around the entire outside of the refrigerator room. This vapor-tight seal is called a vapor barrier. An odorless asphalt-impregnated paper is recommended for this purpose. The approved method of construction is to place this barrier between two thicknesses of lumber that form the outer part of the wall. The lumber used for this purpose should be plywood or tongued and grooved material with no loose knots. Shiplap is not recommended.

The Forest Products Laboratory at Madison, Wisconsin, found that the resistance of papers to vapor transmission varies greatly. As a result of the laboratory findings, it is recommended that the vapor barrier consist of two layers of odorless asphalt-impregnated and coated paper so placed that the joints lap. Ordinary building paper is not satisfactory. The laps should be sealed with hot asphalt emulsion. Care should be taken to get a continuous barrier at all of the corners. Manufacturers of insulating board materials such as cork board frequently have other vapor barrier recommendations upon which one may depend.

All asphalt used should be an absolutely odorless product such as can be obtained from any refrigeration supply house. It has been found that an oxidized Mexican asphalt having a melting point of 180° F. to 200° F. gives the properties desired. (Refrigeration Data Book.)

The inside surface of the wall should not be vapor tight and no vapor barrier should be placed in it. As the average temperature of the wall changes, the volume of the air incorporated in the insulation changes and a certain amount of "breathing" occurs. This breathing must be through the inner surface of the wall rather than the outer surface. Tongue and groove lumber or plywood without a vapor barrier will permit the necessary breathing.

GENERAL CONSTRUCTION

If the refrigeration room is to be built in a basement with a concrete floor, good drainage and an air space between the two floors are essential. If it is built in an existing building having a wood floor, care must be taken to make certain that floor construction is strong enough to support the heavy refrigerator load. A concrete floor with 2″ x 3″ or 2″ x 4″ sleepers laid on it flatwise and two thicknesses of sheathing on top of these with the paper vapor barrier between, as previously described and as shown in Figure 1, constitutes good construction. The air space between the sheathing and the concrete prevents the frost from the freezer room penetrating into the ground and gives necessary ventilation. Two courses of floor joists placed at right angles make possible a well-insulated floor where bulk fill type insulation is used. Insulation is packed between the joists and all space not occupied by structural members is filled with insulating material. To guard against settling and formation of voids in the insulation, the material should be placed firmly enough so there is as little tendency to settle as possible. As examples, kiln-dried planer shavings should be packed so that the density is 8 to 9 pounds per cubic foot, and redwood bark fiber 6.5 to 7 pounds per cubic foot. It is a good plan to put a thickness of vapor barrier paper between the joists where they cross. As soon as all the open space in the floor skeleton has been filled with insulation, the floor can be put on. This should be a good grade of flooring. Car decking is also very satisfactory but probably heavier than necessary for this service.

WALL CONSTRUCTION

In cases where the outside of the wall is accessible, the outer sheathing can be placed outside the studs. Studs are erected and the first layer of sheathing nailed on the outside. The vapor barrier is then applied, after which the outer thickness of sheathing is nailed on. The vapor barrier should extend above the top wall approximately 1 foot so it can be folded over to form a lap joint in the ceiling. Galvanized nails should be used throughout and care should be taken to place nails so they go into the stud.

In the case of walls, particular attention should be given to proper density of the fill material. This is more important in the walls than in the floor or ceiling because if the insulation settles in the walls, it leaves an open space.

In cases where the refrigeration room is constructed inside another room, it is necessary to work from the inside of the structure throughout the construction process. The studs that support the outer sheathing are placed first. The outer thickness of sheathing is then nailed to them from the inside. Next the vapor barrier is placed, as already described, and the inner layer of sheathing nailed in place. The remainder of the construction process is the same as for the first type.

Provision must be made for coil connections to pass through the freezer-compartment wall to the 35° room and also from this room to the outside so that the refrigeration connections can be made without damage to the wall. A $1\frac{1}{4}$-inch conduit should be built into the freezer wall at a point about 4 feet above the floor and a double conduit placed in the wall from the 35° room to the outside, also about 4 feet from the floor. One of these will serve as a passageway for the refrigeration connections and the other for electrical connections. These conduits must be sealed to the vapor barrier and made solid at one end by use of a floor flange.

If a finned coil or blower coil is contemplated for the 35° room, an additional conduit should be extended through the wall to provide a drain for the drip pan underneath the coil. After the installation of the refrigeration equipment the conduit should be filled with a plastic asphalt material.

CEILING CONSTRUCTION

The ceiling is practically the same construction as the floor. Two courses of joists at right angles where bulk fill insulation is used, supported by plates or ribbons, constitute the framing. The inner sheathing that forms the ceiling of the refrigerated space is nailed on and the space filled with insulation. The first thickness of outer sheathing is then put on and the vapor barrier placed. The vapor barrier in the wall, which was extended above the wall so it could be folded over the ceiling vapor barrier, can now be put in place in order to make a continuous vapor proof membrane around the corner. The final thickness of sheathing is then applied.

DOOR CONSTRUCTION

Particular attention should be given to the installation of doors. It is very difficult for a carpenter with ordinary tools to build a cold storage door that will remain air tight and will not warp or sag in service. Leakage around inferior doors is a source of loss of large quantities of refrigeration, particularly when rooms are small. Air leakage and accumulation of moisture occur and an excessive load is placed on the refrigeration equipment to the extent that it may become impossible to maintain desired temperatures. Substantial hardware especially designed for cold storage should be used.

The doors for the farm refrigerator may be of two types: a manufactured door or one that is built on the job. Regardless of the type used, the first consideration is the rough opening that must be framed in the wall during construction of the plant to allow the door and frame to be set in place and fitted properly. The details of framing the rough opening as shown on the working drawings, Figures 3 and 4, were worked out so the construction would be identical for either type door with the size of opening being the only variable.

The recommended over-all thickness of the front wall of the 35° room is 12 inches, and of the front wall of the 0° room is 6 inches, when shavings are used for insulation. This difference in thickness necessitates a slight difference in framing the openings in the two walls.

The front door opening is framed on the side and top with 2" x 12" material ripped down to 10¼ inches. This frame is backed by a 2" x 4" stud on each side for added strength. Across the top of the opening, the 2 x 10¼ rests on the lower member of the double plate that frames the inner wall. The high sill is formed by laying two 2" x 8" pieces on edge on the bottom plate and capping them with another 2" x 4" plate, on which the door sill will rest. The inner siding of ¾-inch T & G is brought into the inside of the rough opening, while the outer siding butts against the casing after it is in place. The vapor barrier is brought around behind the door frame from between the two layers of siding.

The opening into the 0° room is framed on the sides with 2" x 6" material ripped down to 4¾ inches. The top and bottom plates for this wall will also have to be cut to this size. The top of the opening is formed by the top member of the double plate that frames the wall.

The high sill is framed by ripping down two 2" x 6" joists until the sill is flush with the floor, the amount taken off depending on the thickness of the sill.

A table of the rough opening and door sizes:

Door type	*Door size*	*Rough opening*
35° *room*		
1. Standard stock refrigerator door*	2'6" x 6'0"	3'1" x 6'4⅝"
2. Home-built door	3'0" x 6'0¼"	3'3¾" x 6'4⅞"
0° *room*		
1. Standard stock refrigerator door*	2'6" x 5'0"	3'1" x 5'4⅜"
2. Homebuilt door	2'6" x 5'0¼"	2'10" x 5'4⅝"

* These details were taken from the working drawings of a well-known manufacturer of refrigerator doors to give a comparison of the rough opening sizes required. Details should be checked with the manufacturer before installing any stock doors.

The recommendations of the manufacturer should be followed in framing the openings to insure a proper fit of the doors.

THE HOME-BUILT DOOR

Some builders of walk-in refrigerators for home use may wish to build their own insulated doors instead of buying a commercially made door complete with frame and hardware. While this is doubtful economy, plans have been developed using standard materials to meet this situation. The steps in constructing the 35° room door and frame are as follows: (Figures 5 and 6).

The frame is built of 2" x 8" stock for the jamb with inside dimensions of 3'0½" x 6'1" and mortised and tenoned at the corners. The jamb on the latch side of the door is beveled ½ inch to allow the door to swing free when opened and closed. The casing is made from 2" x 6" and fastened to the jamb with lag bolts. A 2" x 3" strip acts as a stop for the door at the top and sides but should be added after the door is hung in order that it may be spaced to allow for the gasket seal on the back of the door.

The basis for the home-built door is a stock five-panel, fir interior door 3'0" x 6'8" x 1¾". This five-panel door must be cut down to 6'0¼" in height by cutting off a portion of both the top and bottom rails, leaving approximately 3⅜ inches on each. As this portion of the finished door fits completely within the frame, this will allow ¼ to ⅜ inch clearance at the top and ⅝ inch at the bottom.

After the stock door has been cut down to the proper dimensions, a 2" x 4" frame, the outer edges of which are the same dimensions as the door, is constructed with mortise and tenon joints at the corners and fastened to the back of the door with lag screws 6 inches to 8 inches on centers. It is advisable also to glue this frame before screwing the door to it.

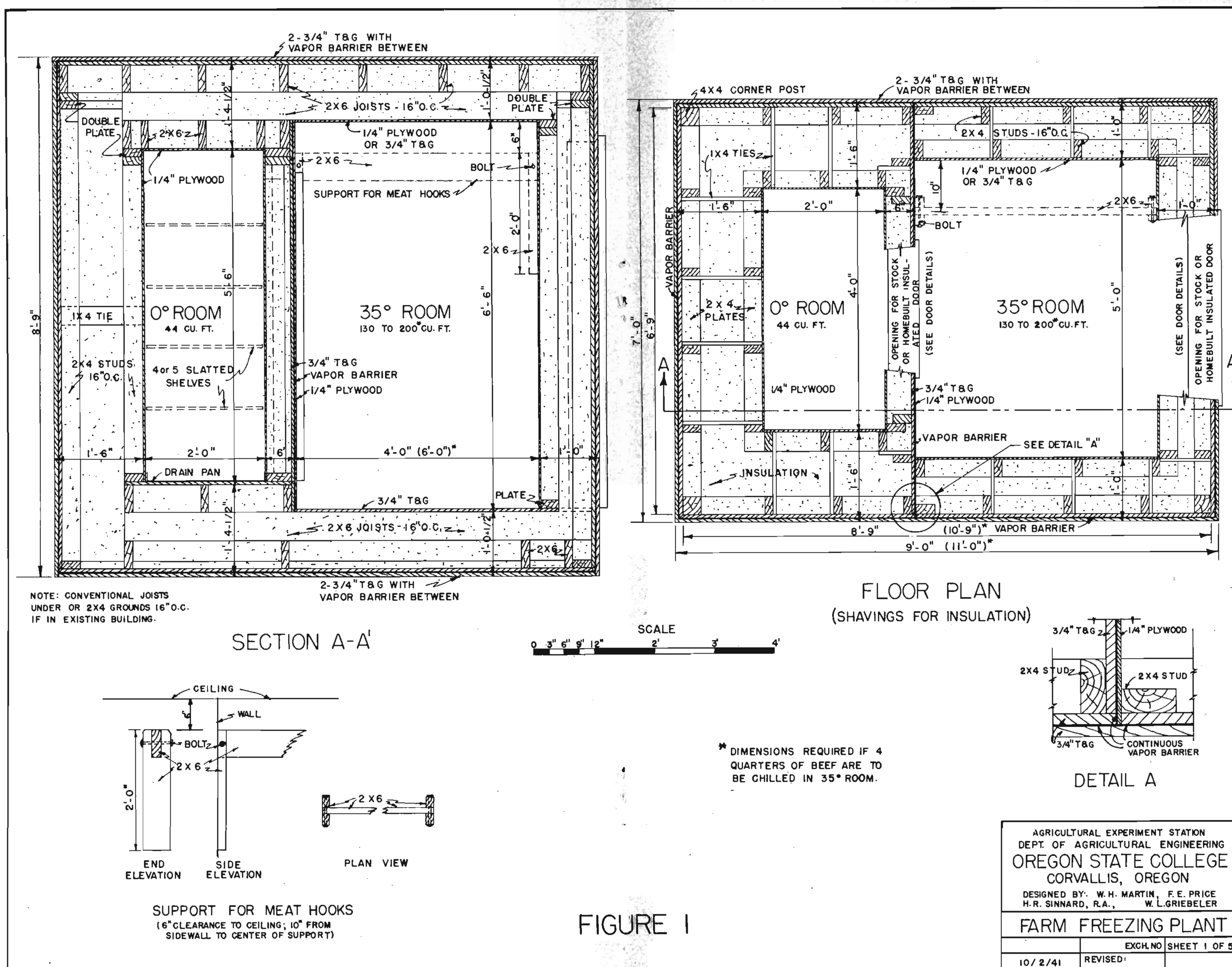
Four pieces of ½-inch insulation board are then cut so they will fit within the frame. Before the panel that rests against the door is put in, it should be covered with a vapor barrier held in place with asphalt. The insulation board panel is then put in place with the vapor barrier against the stock door and secured with coated nails around the edges and across the horizontal rails. Parting strips ½" x ¾" are then placed around the edges of the panel to separate it from the next. Parting strips or scraps of insulation board should be placed horizontally about 12 inches on centers between the panels to break up air circulation in the long ducts formed between them. Each panel is placed in the frame with the strips between until all forms are in place.

The inside of the door is made from ½-inch plywood cut to dimensions, glued, and then fastened all around to the 2" x 4" frame with screws.

The outside of the door is finished with ⅝-inch plywood, which is cut to 6'5" x ¾". This allows for a lap over the casing and for a gasket seal. The gasket is placed all the way around the door on this outside panel and on the top and two sides of the inside panel. The bottom gasket on the inside is of the "floor-sweep" type, fastened between the 2" x 4" frame and the plywood backing.

The entire door should be made of kiln-dried stock and well oiled or painted immediately after construction. Standard refrigerator-door hardware is required and can be purchased from manufacturers of refrigerator doors.

The 0° room door and frame are constructed similar to the 35° room door with the differences in dimensions as shown on the drawings. A 6'6" x 2'6" x 1¾" five-panel door is used and is cut down to 5'0¼". This necessitates cutting off the top rail and panel of the door and trimming down what becomes the top



2-3/4" T&G WITH VAPOR BARRIER BETWEEN
DOUBLE PLATE
2X6 JOISTS - 16"O.C.
1/4" PLYWOOD OR 3/4" T&G
2X6
BOLT
SUPPORT FOR MEAT HOOKS
1/4" PLYWOOD
0° ROOM
44 CU. FT.
35° ROOM
130 TO 200* CU. FT.
1X4 TIE
2X4 STUDS 16"O.C.
4 or 5 SLATTED SHELVES
3/4" T&G
VAPOR BARRIER
1/4" PLYWOOD
DRAIN PAN
PLATE
3/4" T&G
2-3/4" T&G WITH VAPOR BARRIER BETWEEN
8'-9"
5'-6"
6'-6"
2'-0"
1'-6"
4'-0" (6'-0")*
NOTE: CONVENTIONAL JOISTS UNDER OR 2X4 GROUNDS 16"O.C. IF IN EXISTING BUILDING.
SECTION A-A'
CEILING
WALL
BOLT
2X6
2'-0"
END ELEVATION
SIDE ELEVATION
PLAN VIEW
SUPPORT FOR MEAT HOOKS
(6" CLEARANCE TO CEILING; 10" FROM SIDEWALL TO CENTER OF SUPPORT)
SCALE
0 3" 6" 9" 12" 2' 3' 4'
4X4 CORNER POST
2-3/4" T&G WITH VAPOR BARRIER BETWEEN
2X4 STUDS - 16"O.C.
1X4 TIES
1/4" PLYWOOD OR 3/4" T&G
VAPOR BARRIER
2 X 4 PLATES
OPENING FOR STOCK OR HOMEBUILT INSULATED DOOR (SEE DOOR DETAILS)
3/4" T&G
1/4" PLYWOOD
VAPOR BARRIER
SEE DETAIL "A"
INSULATION
(10'-9")* VAPOR BARRIER
8'-9"
9'-0" (11'-0")*
7'-0"
6'-9"
FLOOR PLAN
(SHAVINGS FOR INSULATION)
* DIMENSIONS REQUIRED IF 4 QUARTERS OF BEEF ARE TO BE CHILLED IN 35° ROOM.
3/4" T&G
1/4" PLYWOOD
2X4 STUD
2X4 STUD
3/4" T&G
CONTINUOUS VAPOR BARRIER
DETAIL A
AGRICULTURAL EXPERIMENT STATION
DEPT. OF AGRICULTURAL ENGINEERING
OREGON STATE COLLEGE
CORVALLIS, OREGON
DESIGNED BY: W. H. MARTIN, F. E. PRICE
H. R. SINNARD, R.A., W. L. GRIEBELER
FARM FREEZING PLANT
EXCH. NO SHEET 1 OF 5
10/2/41 REVISED:

FIGURE I

rail to approximately 4 inches in width. The remainder should be taken off the bottom rail. The same construction outline is followed as for the 35° room door after cutting down the stock door, ½-inch bevel to be made in the door and frame on the latch side.

The frame is made of 2" x 6" material, allowing ¼-inch clearance on both sides of the door, ⅜-inch clearance at the top and ⅝-inch at the bottom. A ⅞" x 1⅝" stop is placed behind the door and reinforced by putting a 2" x 4" casing on the inside, screwed to the stop and to the studding.

There are several reputable manufacturers* with many years' experience in cold-storage door construction who can furnish a much better product than a home-made door.

INTERIOR WALL AND DOOR FINISH

Two coats of boiled linseed oil are recommended for all interior wood surfaces. The first coat should be especially well brushed to aid penetration.

REFRIGERATION SURFACE

The freezer room. The cooling surface installed in the freezer compartment should be preferably a bare coil usually ⅝- or ¾-inch copper tubing. The effectiveness of such a coil remains more nearly constant as frost accumulates and frequent defrosting is not necessary. Blower coils are sometimes used successfully for low temperatures but they present special operating problems, which it is desirable to avoid. The amount of coil surface in the freezer room should be sufficient to absorb the maximum heat that must be taken up in this compartment per unit time with a difference between compartment temperature and coil temperature not greater than 15° F.

The 35° room. The surface installed in the 35° space can be bare coil, finned surface, or a blower coil. The performance of any one of the three is satisfactory provided the proper size is selected. The choice can be based on cost. The allowable average temperature difference between coil and room if natural circulation is used is about 13° to 15° F., but if a blower coil is used the average temperature difference should not be more than 10° F., if excessive drying of products in storage is to be avoided. The design and arrangement of the coil can be left to manufacturers' recommendations. All reputable manufacturers are prepared to state the conditions under which their own product will perform best.

For example let us suppose that a finned coil is desired that will absorb 2,000 Btu per hour when the temperature difference is 13° F. A certain manufacturer has a unit having a rated capacity of 2,080 Btu per hour under these conditions and it is the one to be selected.

In buying the coils for the refrigeration rooms the following conditions and requirements should be specified:

1. Room temperature to be maintained.
2. Not greater than 15° F. difference between coil and freezer room temperature.
3. Bare copper tubing only allowed in freezer room.
4. Inside dimension of room and thickness and kind of insulation.
5. Maximum amount of product to be cooled or frozen per 16-hour period.

* Names of door manufacturers can be obtained by writing to the Agricultural Engineering Department, Oregon State College.

POWER CONSUMPTION

Based on the power required to operate similar refrigeration plants, it is estimated that the unit described in this circular will require about 100 kilowatt hours per month.

CONTROLS

The sketch shown in Figure 2 illustrates a system of control that is quite satisfactory and as inexpensive as can be expected for good operation. The evaporation of refrigerant in each compartment is controlled by a thermostatic expansion valve (A) actuated by the pressure built up by a liquid in a bulb (D) clamped to the evaporator near the outlet. The check valve (B) is placed on the outlet of the freezer-room coil to prevent the refrigerant from entering in reverse direction. A solenoid valve (C) on the outlet of the 35° room coil is operated by a thermostat (T) in the room. This thermostat can be adjusted to permit carrying of temperatures above or below the design level. The compressor is stopped and started by a suction pressure operated switch (P). When the pressure in the suction line drops to a certain predetermined level, the switch opens and shuts off the compressor. When the suction pressure builds up to a certain higher level, the switch closes and the compressor starts. In case the freezer temperature rises, the bulb of the thermostat valve warms and causes a pressure rise in the bulb, which is transmitted through the small tube (E) to the valve (A). This increased pressure is exerted on a diaphragm, which causes the valve to open. Flow of liquid refrigerant into the coil raises the pressure in it and in the suction line, the pressure switch operates and the compressor starts.

As the temperature in the 35° room rises, the thermostat causes the solenoid valve to snap open and allow vapor from the room coil to pass into the suction line. This raises the pressure and causes the compressor to start, if it is not already running. This system makes it possible to control the temperature in either the freezer or the 35° room, each independent of the other. Furthermore, it makes possible an automatic defrosting cycle in the 35° room. During the off period the coil warms to practically room temperature, and since this is above freezing the frost tends to melt.

In order to limit the maximum temperature differential between the coil and the 35° room, as recommended on page 12, a pressure reducing valve is required.

If the 35° room coil is operated at the same pressure as the freezer coil, an excessive temperature differential between the coil and the room results, and relative humidity is reduced to such an extent that food stored for some time dehydrates unless stored in airtight containers. This is caused by operating the coil at an excessively low temperature resulting in excessive frost accumulation, which is evidence of the loss of moisture from food in the room. By placing a pressure regulating or pressure reducing valve just ahead of the solenoid valve a higher pressure and consequently a higher coil temperature can be maintained, less frost accumulation will result, and less moisture will be removed from goods being stored. Under these conditions a somewhat larger coil is necessary and this with the extra valve means a slightly greater cost. The additional expense, however, is only $10.00 or $15.00, and since this is a small percentage of the total cost it is recommended.

A dehydrator for absorbing any moisture that may get into the refrigerant should be placed in the liquid line. Each expansion valve should be preceded by a filter to remove any solid particles that may reach the small openings in the valve and clog them.

A heat exchanger that serves to warm the suction vapor by removing the heat from the liquid on its way to the coil is often recommended. While this is a somewhat controversial question, it can be shown that under certain conditions such a device reduces compressor capacity. A much better procedure is to insulate the suction line so that the vapor can return to the compressor as cold as possible.

To protect against excess pressure a high-pressure cutout is desirable, but not so necessary for air-cooled refrigeration as for a water-cooled unit.

Occasionally it is desired to connect a household unit to the same refrigeration unit as the freezer and 35° compartment. In such a case a set of controls consisting of an automatic or a thermostatic expansion valve on the inlet and a thermostat and solenoid valve on the outlet of the coil similar to those used for the 35° room is necessary.

DEFROSTING

In order to collect the moisture when defrosting, a pan is placed under a coil of the 35° room. A drain through the conduit previously mentioned should extend from this pan to the outside of the compartment. Defrosting the freezer room coils should not be required more than two or three times a year, but since the frost comes off in solid form, three removable pans that can be easily taken out to be emptied may be fitted into the bottom of the compartment.

ELECTRICAL SERVICE

Electrical wiring must be provided for the compressor motor, and in the 35° room electric service must be provided for the thermostat, the solenoid suction valve convenience outlet, and lights in the room. The light in the 35° room should be located in the ceiling or on the wall, and both should be controlled by a switch on the outside equipped with a telltale to indicate whether or not the light is on. Care should be exercised to keep lights turned off when not in use because the heat evolved adds to the refrigeration load.

During below-freezing weather it may be necessary to add heat in the 35° room to prevent freezing. A plug-in connection should be provided so that an electric heater may be operated when needed.

The freezer compartments can be served by the light in the 35° room or a portable light in the form of an extension with a clamp, which makes it possible to attach it temporarily to any convenient point.

COST

Any estimate of cost can be only a rough approximation and any figures given herewith should be regarded merely as indicative. The refrigeration equipment, if purchased new and properly installed, will probably cost not less than $350.00. About half of this is for the condensing unit. Manufactured doors cost approximately $60.00 each. If a home-made door is built its cost will be less, but the quality will be definitely inferior. The material and labor for the structure probably will be about $100.00. The total cost including materials, equipment, and installation of the refrigeration equipment would be about $600.00.

FARM FREEZING PLANT

Summary of Estimated Cost of Materials and Equipment
50 cubic feet 0° F. storage—150 cubic feet 35° F. storage
(Cost of installing refrigeration equipment must be added)

Compressor, including pressure control switch	$175.00
Coil for freezer	60.00
Coil for 35° room	35.00
High pressure cutout	7.50
2 Thermo valves	15.00
1 Check valve	3.00
1 Pressure regulating valve	8.00
2 Filters	12.00
1 Thermostat	5.00
4 Shutoff valves	12.00
1 Solenoid snap action valve	15.00
2 Doors	120.00
Structure, including insulation (shavings)	100.00
Total estimated cost (will vary as prices change)	$567.50

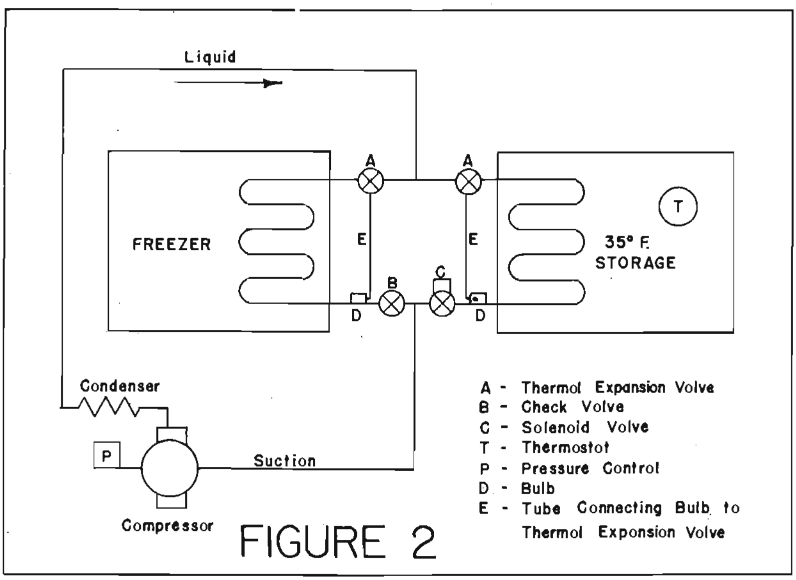


Figure 2. This diagram shows refrigerator lines and controls recommended for 0° and 35° F. rooms. A small household refrigerator could be included in the hook-up by using another set of controls as required for the 35° room.

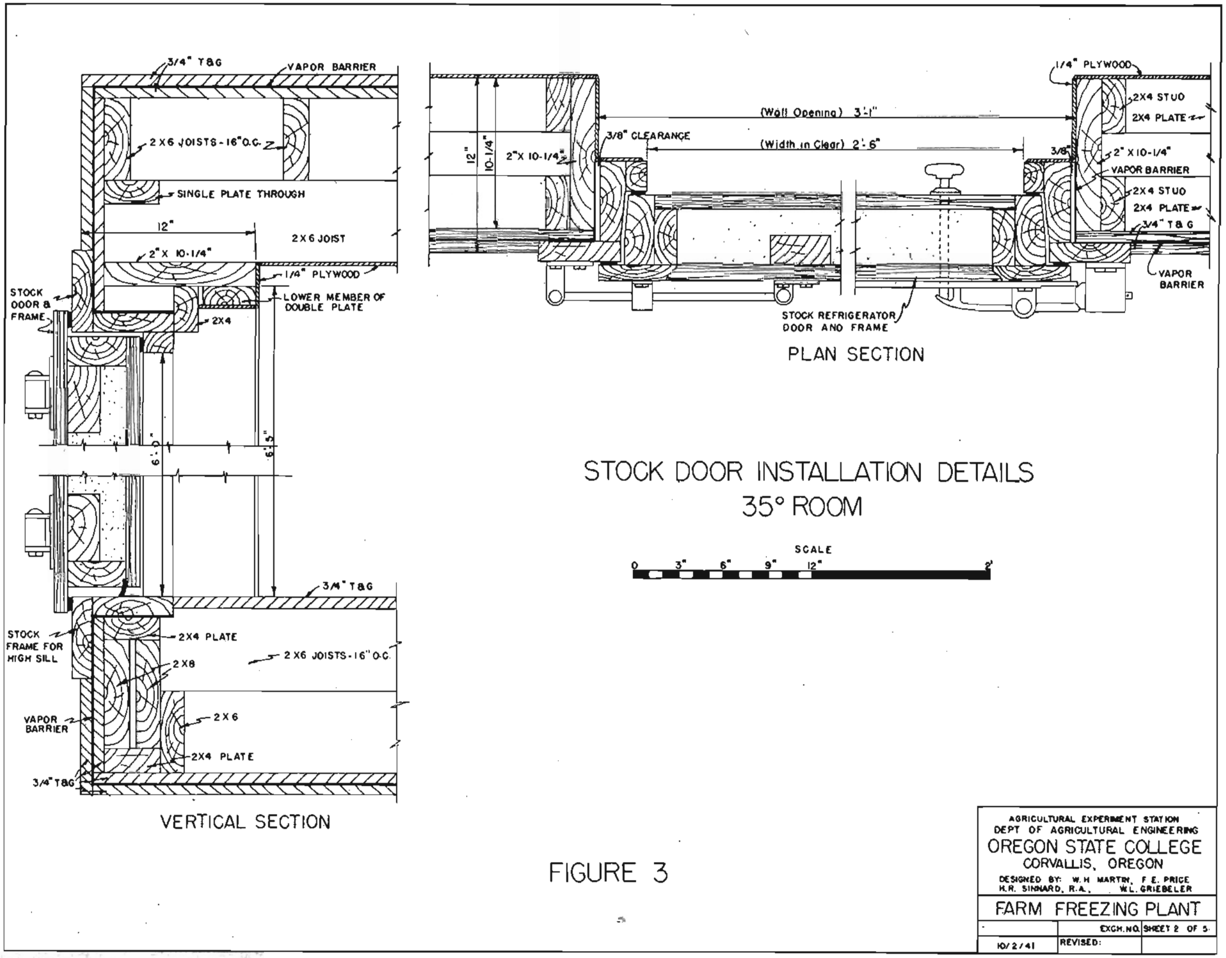
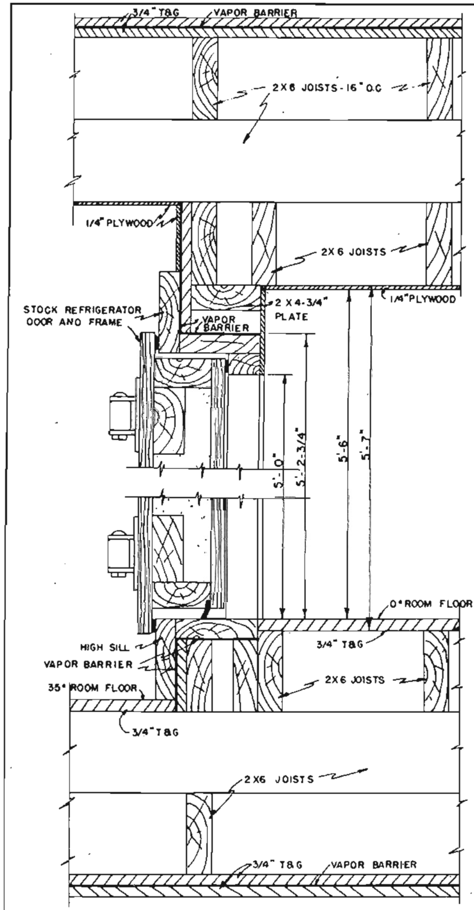
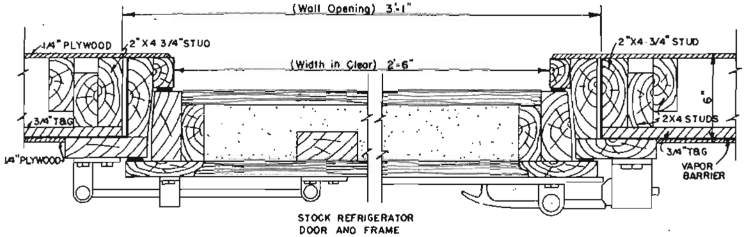

3/4" T&G
VAPOR BARRIER
2 X 6 JOISTS - 16" O.C.
SINGLE PLATE THROUGH
12"
2 X 6 JOIST
2" X 10-1/4"
1/4" PLYWOOD
LOWER MEMBER OF DOUBLE PLATE
2X4
STOCK DOOR & FRAME
6'-0"
6'-5"
3/4" T&G
STOCK FRAME FOR HIGH SILL
2X4 PLATE
2X8
2 X 6 JOISTS - 16" O.C.
2 X 6
VAPOR BARRIER
2X4 PLATE
3/4" T&G
VERTICAL SECTION
12"
10-1/4"
2" X 10-1/4"
3/8" CLEARANCE
(Wall Opening) 3'-1"
(Width in Clear) 2'-6"
3/8"
1/4" PLYWOOD
2X4 STUD
2X4 PLATE
2" X 10-1/4"
VAPOR BARRIER
2X4 STUD
2X4 PLATE
3/4" T & G
VAPOR BARRIER
STOCK REFRIGERATOR DOOR AND FRAME
PLAN SECTION
STOCK DOOR INSTALLATION DETAILS
35° ROOM
SCALE
0 3" 6" 9" 12" 2'
AGRICULTURAL EXPERIMENT STATION
DEPT OF AGRICULTURAL ENGINEERING
OREGON STATE COLLEGE
CORVALLIS, OREGON
DESIGNED BY: W. H. MARTIN, F. E. PRICE
H.R. SINNARD, R.A., W.L. GRIEBELER
FARM FREEZING PLANT
EXCH. NO. SHEET 2 OF 5
10/2/41 REVISED:

FIGURE 3



VERTICAL SECTION



PLAN SECTION

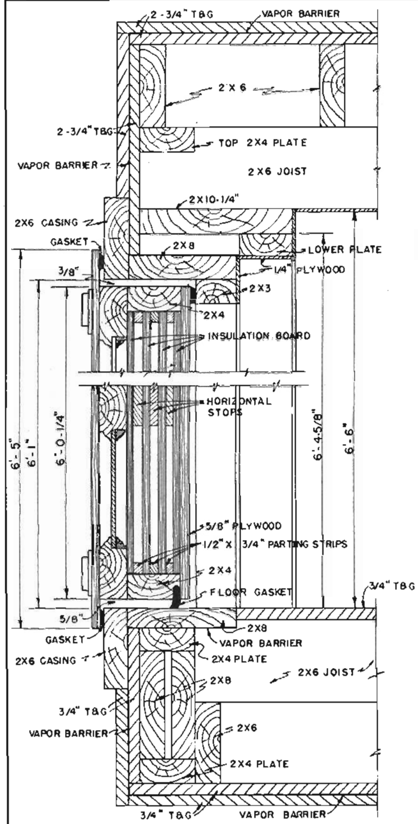
STOCK DOOR INSTALLATION DETAILS
0° ROOM

SCALE
0 3" 6" 9" 12" 2'

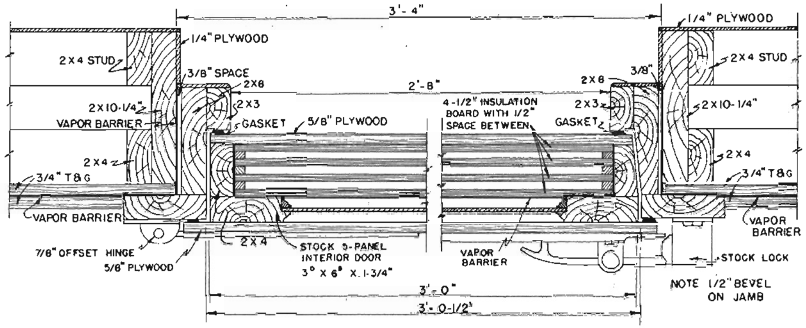
FIGURE 4

AGRICULTURAL EXPERIMENT STATION
DEPT OF AGRICULTURAL ENGINEERING
OREGON STATE COLLEGE
CORVALLIS, OREGON
DESIGNED BY W. H. MARTIN, F. E. PRICE
H.R. SINNARD, R. A., W. L. GRIEBELER

FARM FREEZING PLANT		
	EXCH NO.	SHEET 3 OF 5
10/2/41	REVISED	



VERTICAL SECTION



PLAN SECTION

HOME BUILT DOOR DETAILS
35° ROOM

SCALE
0 3" 6" 9" 12" 2'

FIGURE 5

AGRICULTURAL EXPERIMENT STATION
DEPT. OF AGRICULTURAL ENGINEERING
OREGON STATE COLLEGE
CORVALLIS, OREGON
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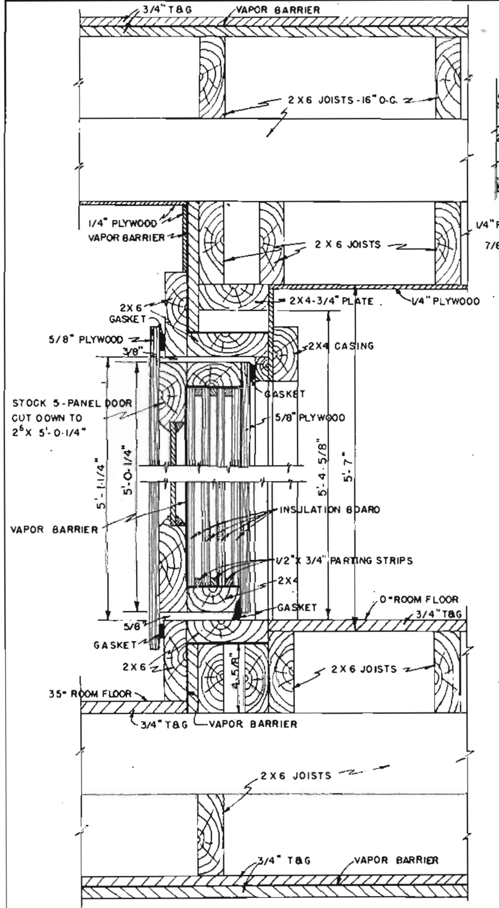
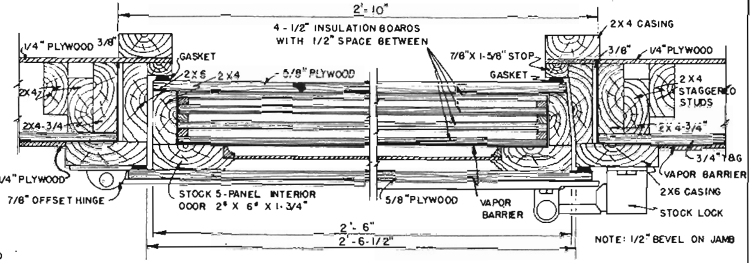
H. R. SINNARD, R.A., W. L. GRIEBELER

FARM FREEZING PLANT

	EXCH. NO.	SHEET 4 OF 5
10/2/41	REVISED:	



VERTICAL SECTION



PLAN SECTION

HOME BUILT DOOR DETAILS
0° ROOM

SCALE
0 3" 6" 9" 12" 2'

FIGURE 6

AGRICULTURAL EXPERIMENT STATION DEPT. OF AGRICULTURAL ENGINEERING OREGON STATE COLLEGE CORVALLIS, OREGON DESIGNED BY: W. H. MARTIN, F. E. PRICE H.R. SINNARD, R.A., W.L. GRIEBELER		
FARM FREEZING PLANT		
	EXCH. NO	SHEET 5 OF 5
10/2/41	REVISED	