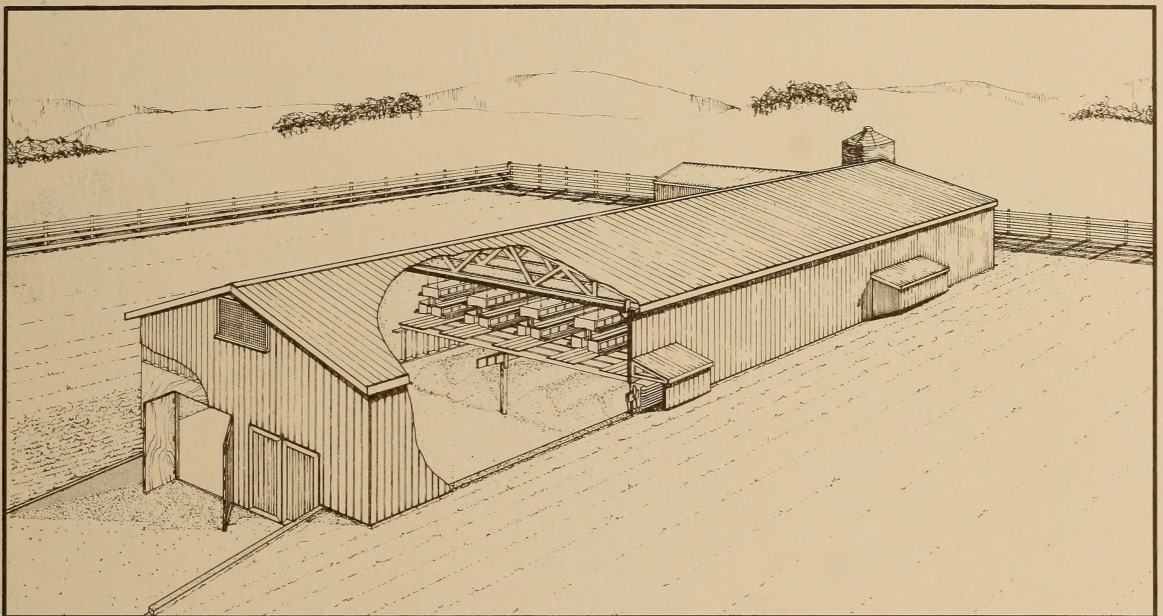
Poultry Housing Facilities



Agdex No. 450/721-1

Alberta
AGRICULTURE
Engineering and
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Edmonton, Alberta, T6H 5T6
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Revised 1989 04 (1M)

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AGRICULTURE
Engineering and Rural Services Division

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INTRODUCTION

A. SITE SELECTION

Regardless of the type of poultry production being considered, a relatively large building site is required. Future expansion should always be considered in order to allow for increased quota allotments. The proposed building site should be reasonably level to accommodate manure handling, feed handling, egg handling, etc. Having all farm buildings elevated in a similar manner will make it easier to tie the systems together later on. Good drainage away from the buildings is also required to prevent seepage into manure pits and the rapid deterioration of the building itself.

Depending on the number of barns and the desired layout, space must be provided between the barns for proper ventilation, fire safety, and snow and wind control. A distance of 15 to 30 m (50 to 100 ft) is usually adequate and still practical.

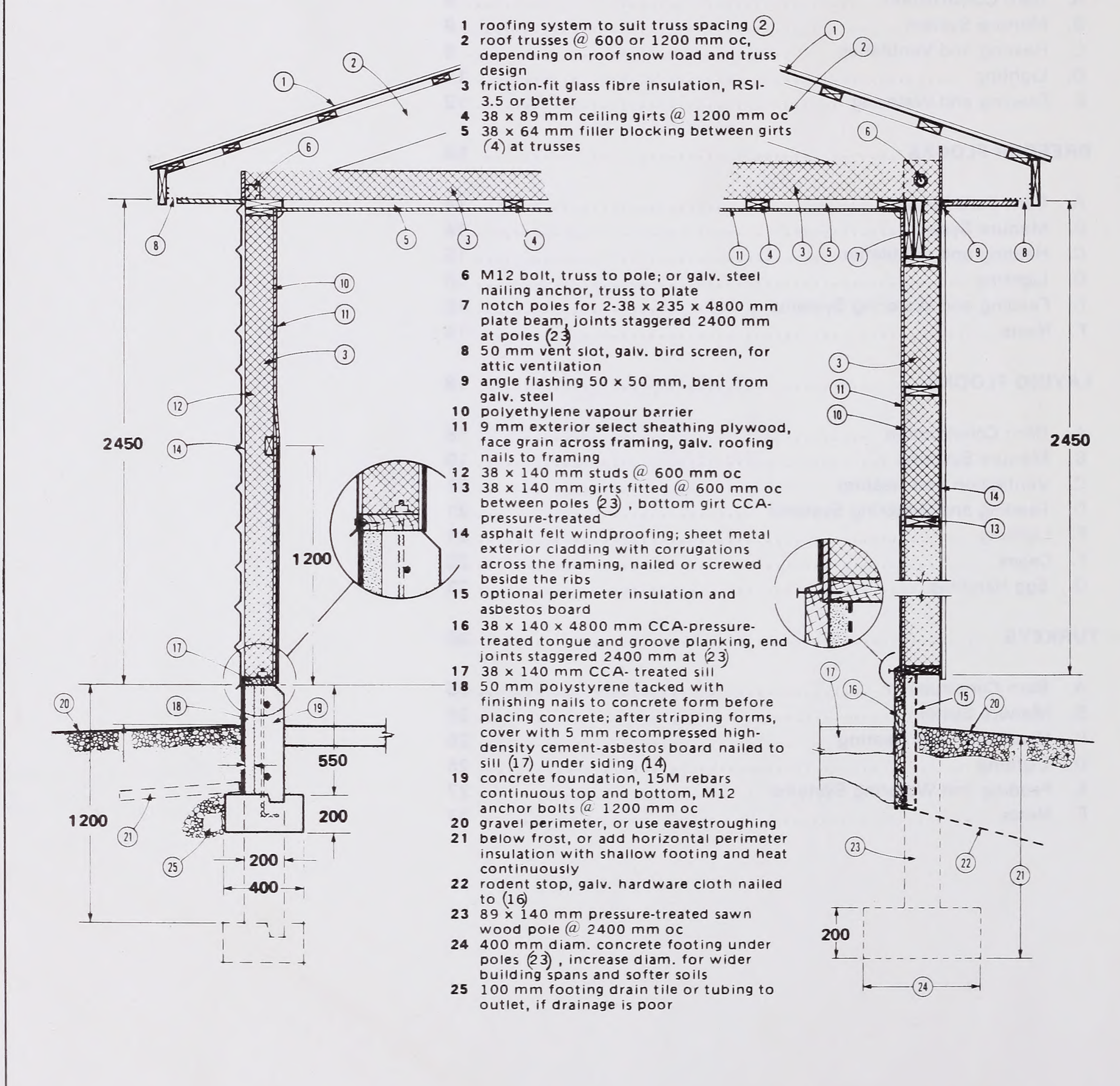


Figure 1a - Insulated stud-frame wall construction

Figure 1b - Insulated post-frame wall construction

B. BUILDING CONSTRUCTION

Stud wall, shallow concrete foundation, clear span truss rafter and pole frame, clear span truss rafter as shown in Figure 1, are the two construction types most frequently found in poultry buildings.

Another modification of a pole frame building is shown in Figure 2. This style provides an insulated roof rather than an insulated celing. This type of pole frame building, along with a rigid frame (Figure 3) or a wooden arch-rib building (Figure 4), can easily accommodate the air distribution tubes required for a positive-pressure ventilation system.

An insulated pole frame building is considered the most economical form of construction. The insulated stud wall and rigid frame construction are next, with the insulated wooden arch-rib being the most expensive. At current prices, there is only about a 5% cost difference between each of these but this may be worth considering.

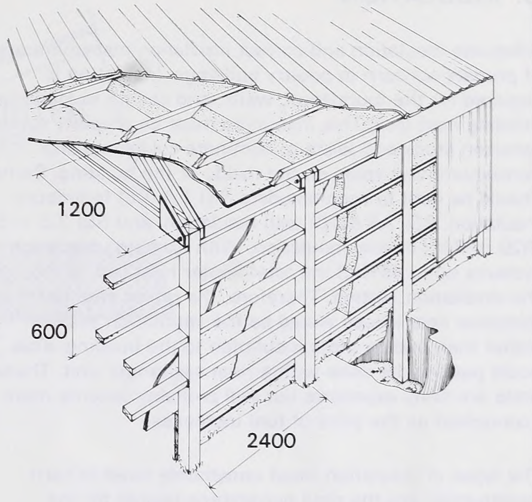


Figure 2 - Post-frame building with insulated roof

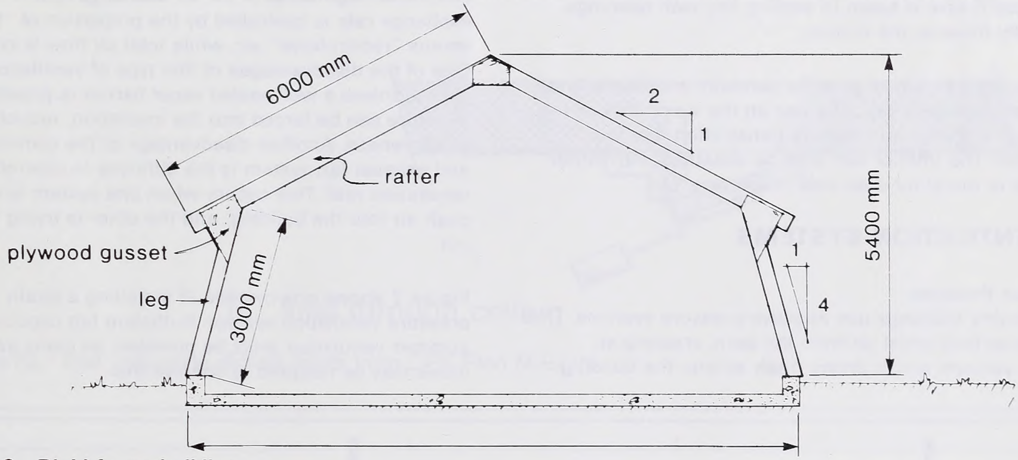


Figure 3 - Rigid frame building

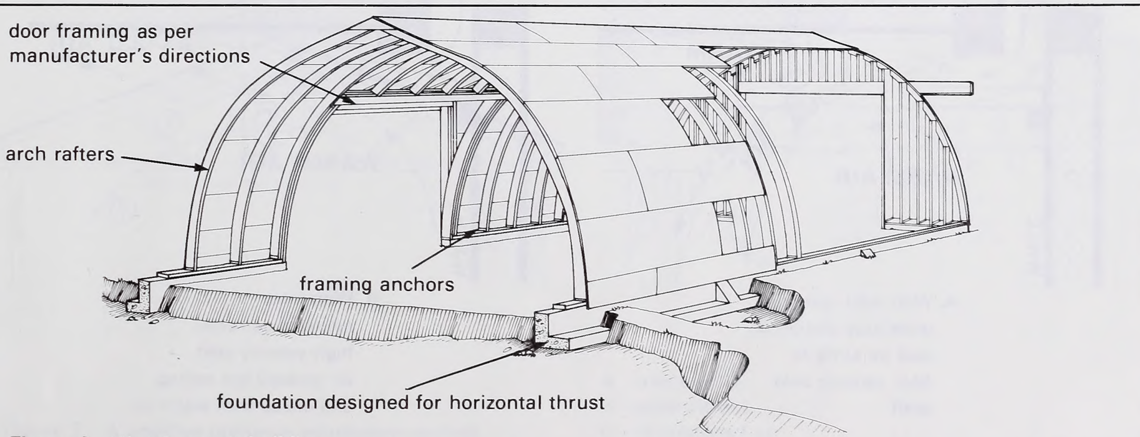


Figure 4 - Wooden arch building

C. INSULATION

Adequate insulation and correct insulation placement are of primary concern in poultry buildings. Insulation is required for the foundation, walls, and ceiling to minimize building heat loss. This insulation must be properly placed between studs and joists to eliminate cold spots and consequent wet spots on the inside of the building. Barns should be built to accommodate RSI 1.4 (R8) foundation insulation, RSI 3.5 (R20) wall insulation, and RSI 3.5 to 5.3 (R20 to R30) ceiling insulation. With existing ventilation systems up to 85% of the total winter heat loss is through the ventilation system. Therefore, the prime area to try to minimize heat losses would be the ventilation system rather than adding more insulation to the building. This could possibly be done with a heat exchanger unit. These units are fairly expensive but will probably become more economical as the price of fuel increases.

The types of insulation **most commonly used** in barn construction are the rigid polystyrene boards for the foundations, fibreglass batts for the walls, and either fibreglass batts or cellulose fibre blown-in insulation for the ceiling. Rodent damage to the building can be minimized if care is taken in sealing any wall openings, especially those at the bottom.

The insulated structure must be carefully and totally lined with a polyethylene vapor barrier on the warm side of the wall. This will prevent moisture penetration into the insulation. The interior can then be sheathed with either plywood or metal for a durable inside finish.

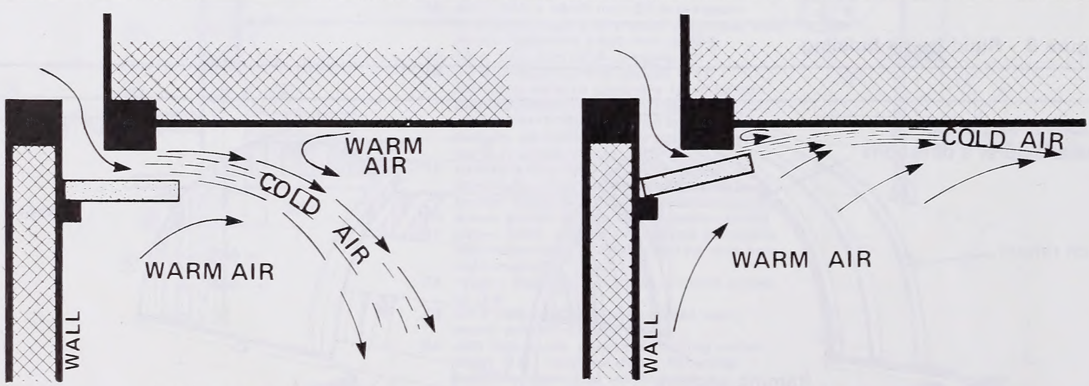
D. VENTILATION SYSTEMS

Negative Pressure
Most poultry buildings use negative pressure systems. That is, exhaust fans expel air from the barn, creating an interior vacuum which draws fresh air into the building.

The exhaust fans must have the capacity to handle large volumes of air required in the summer, and lower rates for other seasons. Air distribution and mixing within the barn is controlled by the air inlet or baffle system. A well constructed air inlet baffle that can be adjusted to maintain a desired velocity of 4 to 5 m/sec (800 to 1000 ft/min) is required. This is achieved by providing 1.0 m^2 to 1.25 m^2 of inlet area for each 5000 L/sec of fan capacity (or providing 1.0 ft^2 to 1.25 ft^2 per 1000 cfm). This velocity is very critical, especially in colder temperatures, to ensure good air mixing, and to prevent drafts. Figure 5 illustrates this principle. Construction details are shown in Figure 6.

Positive Pressure
A positive ventilation system is one in which fans force fresh air into the barn causing a slight pressure. This pressure forces the moisture-laden exhaust air out through the exhaust ports. Some systems also incorporate wall exhaust fans for summer conditions since the pressurizing fans do not have the capacity to meet summer ventilation requirements. The main advantage of the positive pressure system is that it provides excellent air distribution throughout the building. Air distribution ducts, together with the air blending features provide continuous air circulation regardless of the air exchange rate. The air exchange rate is controlled by the proportion of "fresh" versus "recirculated" air, while total air flow is constant. One of the disadvantages of this type of ventilation system is that unless a well sealed vapor barrier is provided, moisture can be forced into the insulation, reducing its effectiveness. Another disadvantage of the combined tube and exhaust fan system is the difficulty in controlling the ventilation rate. This occurs when one system is trying to push air into the building, and the other is trying to pull it out.

Figure 7 shows one method of installing a totally positive pressure ventilation system. Sufficient fan capacity for summer ventilation must be provided; as many as four tubes may be required to achieve this.



A. With inlet open too wide, lazy stream of cold air sinks to floor causing cold draft

B. With inlet adjusted correctly, high-velocity cold air sweeps the ceiling and mixes with warm air

Figure 5 - Control the air velocity and mixing effects by adjusting the fresh air inlet slot

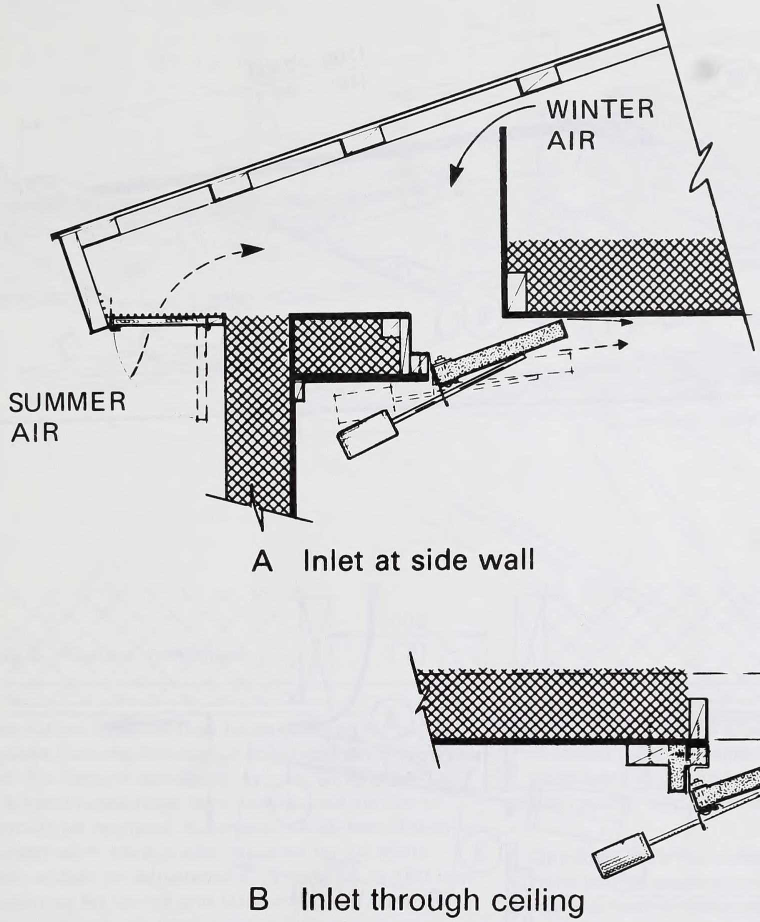


Figure 6a Self -adjusting slot air inlets from CPS Plan M-9715

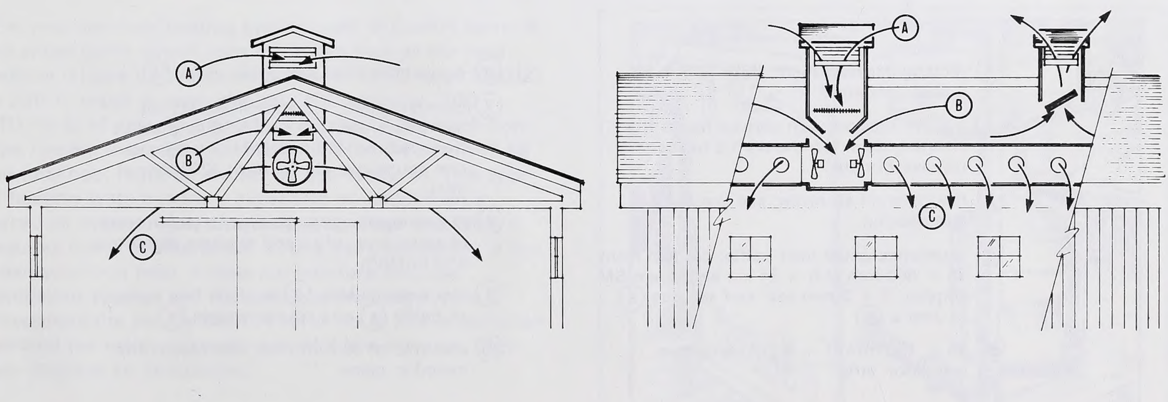
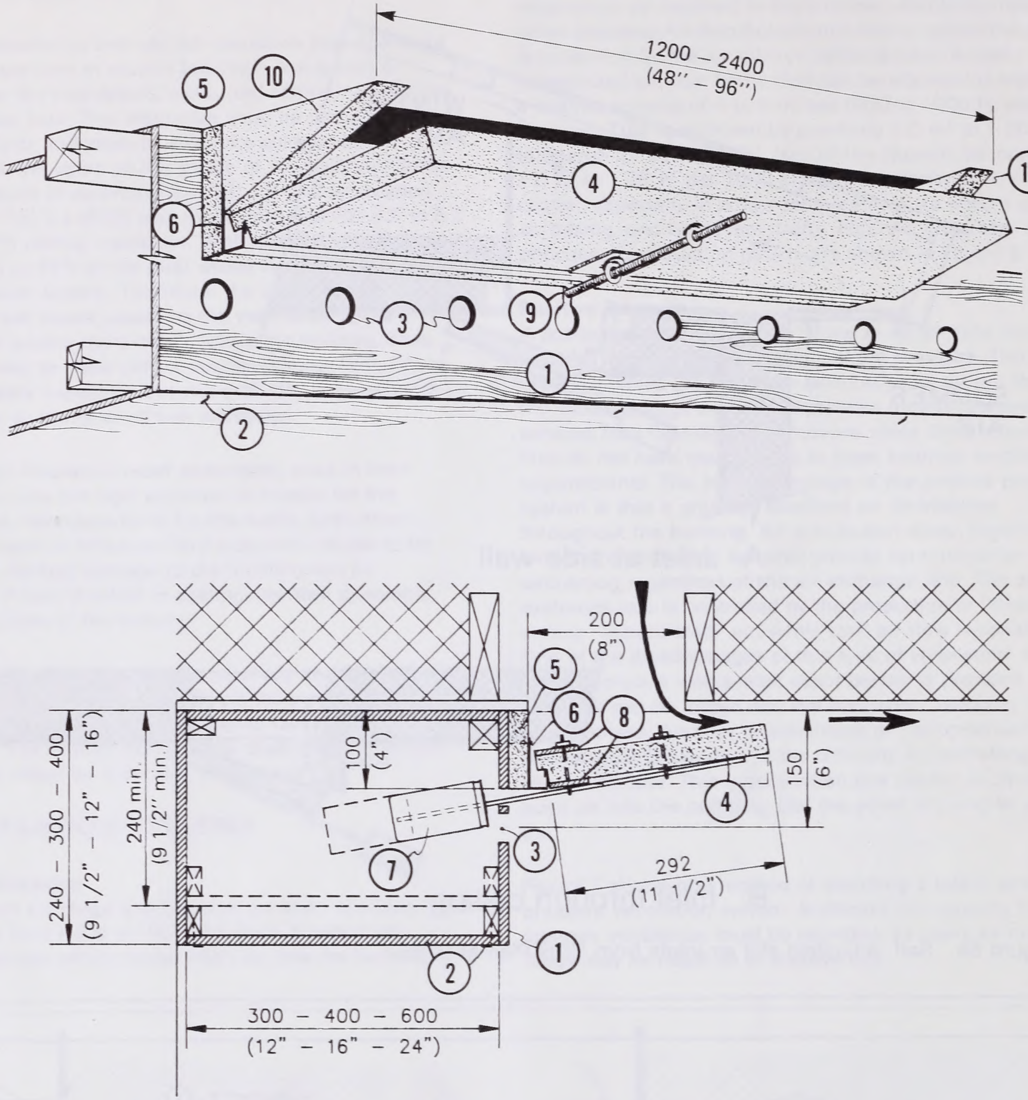


Figure 7 - A positive pressure ventilation system

A - fresh air in
B - stale air out
C - recirculated air



(1) rectangular duct made from 12.5 mm (1/2 in.) plywood

(2) bottom secured with cornice hooks; for cleaning duct, turn hooks 1/2 turn and remove bottom

(3) recirculation air holes; see text for size and spacing

(4) counterweighted inlet baffle; cut two from 38 × 600 mm (1.5 × 24 in.) styrofoam SM shiplap; 3 × 3 mm saw kerf secures (4) to J-strip (6)

(5) 25 × 100 mm (1 × 4 in.) styrofoam insulation strip

(6) prepainted steel J-strip, hinge for (4)

(7) counterweight; concrete-filled 341 mL aluminum beer can with 5/16 in. plated threaded rod 450 mm (18 in.) long; use one counterweight for each 1200 mm of inlet

(8) plated washer brazewelded to slot in head of stove bolt, plywood washers glued top and bottom

(9) slot extends hole (3) to allow free swing of baffle (4) and counterweight (7)

(10) end stop of 25 mm (1 in.) styrofoam and nailed in place

Figure 6b Details of recirculation duct and intergrated self-adjusting fresh air inlet

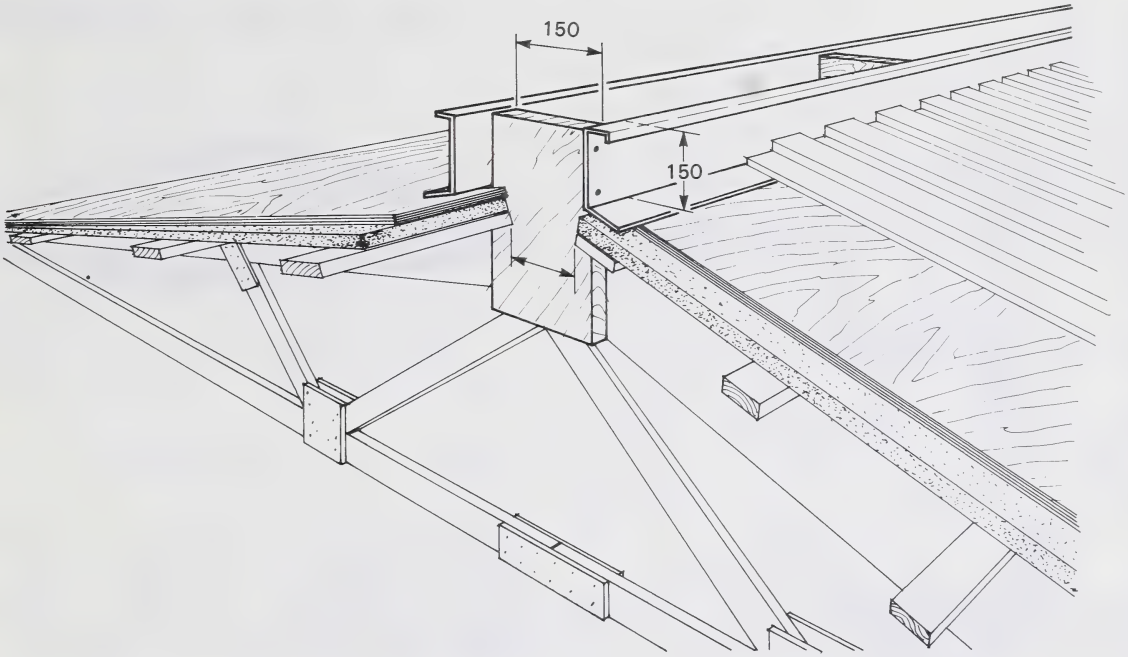


Figure 8 - Natural ventilation

Natural ventilation systems may be considered for turkey, duck, or goose housing although mechanical'ventilation is often used. If a natural ventilation system were to be installed, a continuous ridge vent constructed similar to Figure 8 would be required. A continuous 35 mm (1⅜ in.) opening under each eave is also required for air inlets. These inlets should be adjustable to provide up to 150 mm (6 in.) of opening for spring and fall ventilation. Summer ventilation would require large hinged drop panels or removable panels in the wall to make sure there is an adequate air flow.

E. HEATING SYSTEMS

The most common heating system used in poultry barns is hot water boiler which uses black iron pipe as the heat radiator (Figure 9). Water temperatures of 93 to 98°C (200 to 208°F) result in approximately 200 watts/m (200 BTU/hr-ft) of pipe. The length of 50 mm (2 in.) black iron pipe needed to provide sufficient heat for the barn will be the total heat required divided by 200 watts/m. This type of heating system is more expensive to install than a forced air system. However, it does not require a filter; it requires lower maintenance; it runs more efficiently; it is a clean source of heat; it does not interfere with the ventilation system; and it distributes the heat evenly throughout the poultry barn. A variation of this is using fan assisted hot water radiators spaced down the barn. This may improve air circulation.

A forced air system (Figure 10) may be more economical than a hot water system in smaller operations such as small laying barns. However, it is a high maintenance heat source because of the recirculated dust and moisture.

A gas-fired, hooded brooder (Figure 11) can also be more practical than hot water for a small broiler operation, but it adds extra moisture to the air and it constitutes a greater fire hazard. It is a low cost system.

Gas-fired intra-red radiant tube heaters (Figure 12), may have limited applications in some livestock buildings. They use the heat of combustion from several flame units to heat a length of pipe which radiates the heat onto the birds. The system only provides heat and comfort to the birds and does not provide heat to warm the barn air (except for some re-radiation from the warmed surfaces). Consequently, some moisture build-up in the barn occurs

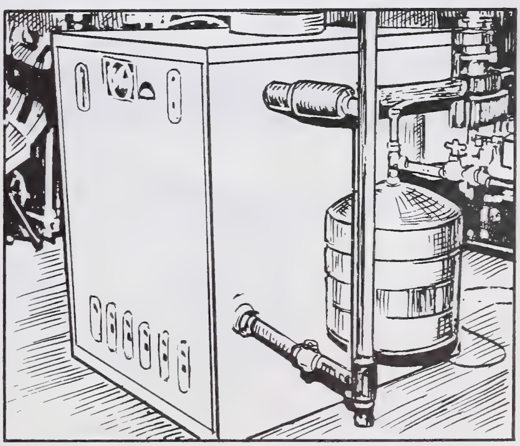


Figure 9 - Boiler and expansion tank

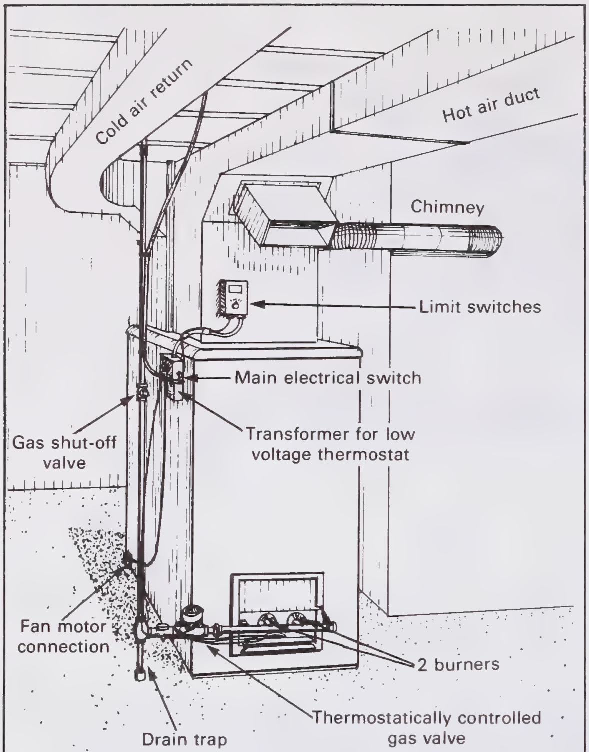


Figure 10 - A forced air heating system

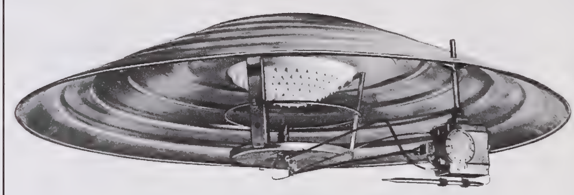


Figure 11 - A gas-fired, hooded brooder

at lower temperatures (below -20°C, (-4°F) outside). This is caused by ventilation rates being reduced to maintain a reasonable inside barn temperature. An infra-red radiant tube heater is comparable in cost to a hot water heating system, but has a lower fuel consumption rate. This is because it heats a surface rather than a whole building.

As previously mentioned, heat exchangers (which recover waste heat from ventilated air) may become very prominent in livestock buildings. If the units can recover enough waste heat to replace the need for a regular heating unit (such as in some laying barns), they may be a possible alternative heat source.

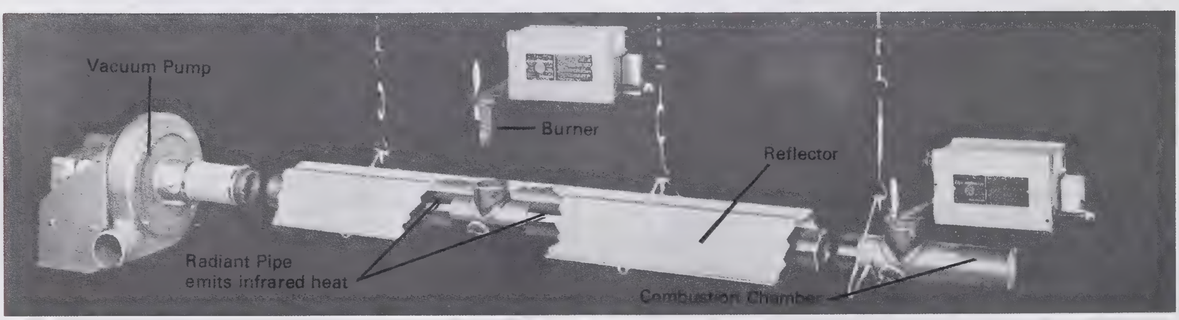


Figure 12 - A gas-fired, infra-red radiant tube heater

BROILER HOUSING

A. BARN CONSTRUCTION

Broiler barns are single or multi-storey barns (Figure 13 and 14) constructed by either the pole-frame or stud-wall method. Two and three storey barns are becoming popular because of lower construction costs and heat savings. Barn construction costs can be reduced by about 15% per floor if a multi-storey barn is built, and energy costs can be reduced as much as 20 to 50%, depending on the age of the broilers. The main disadvantage of two and three storey barns is the row (or rows) of floor support posts which have to be worked around during clean-out, as well as loading problems.

Rigid-frame or wooden arch-rib buildings can also be used for broiler barns if a high ceiling is needed (i.e. when mounting a positive pressure-tube ventilation system).

Floor rearing is common in most broiler barns which have a simple packed clay floor. Straw or shavings are placed on the floor for litter. Good management of leaking waterers and proper clean-out is required to maintain the firm clay base. Disinfection of the clay base after clean-out must also be done on a regular basis.

Concrete floors are easier to clean but are more costly. Some operators are installing 19mm (¾ in.) hot water floor

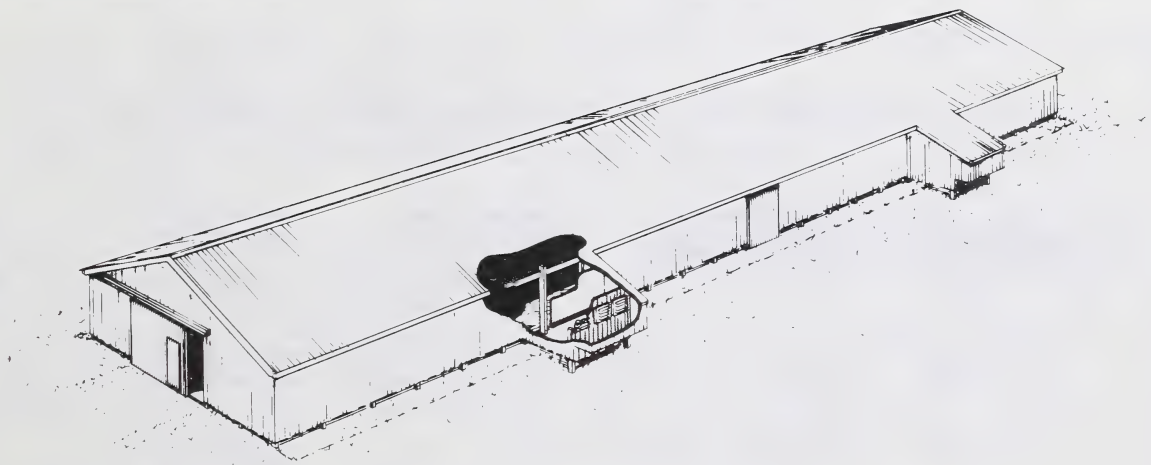


Figure 13 - General purpose, single storey poultry barn (C.P.S. plan no. 5101)

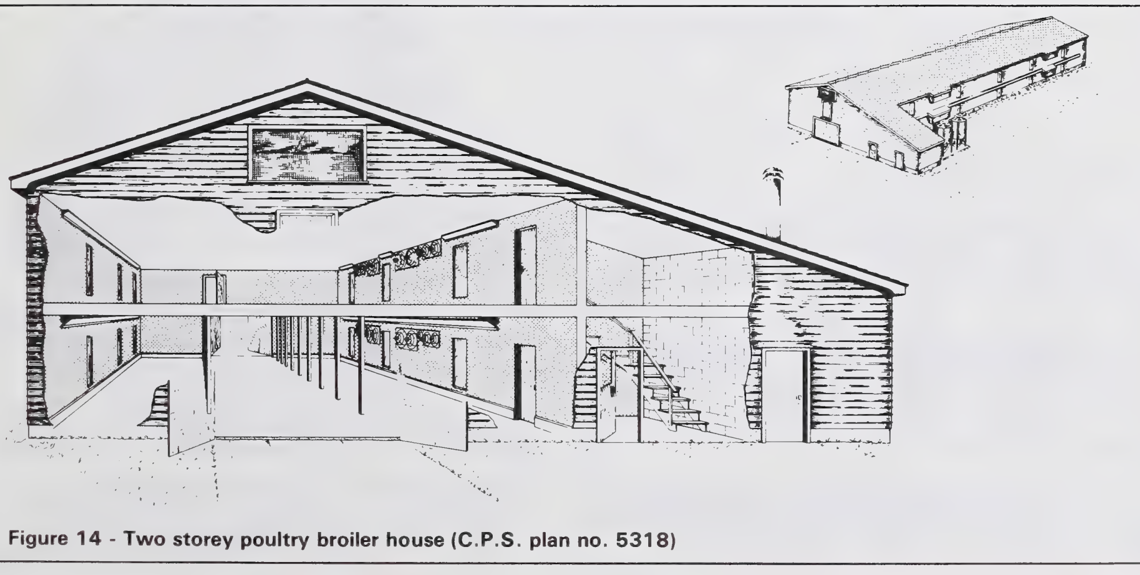


Figure 14 - Two storey poultry broiler house (C.P.S. plan no. 5318)

heating pipe in the sand layers below the concrete floor. This requires less litter and provides warm, even brooding conditions. The warm floor helps dry the litter for older birds so the manure is dry and reasonably odor-free at clean-out. This is an expensive heating system which must be carefully controlled, as dehydration of chicks is also more likely to occur.

An attempt is being made at rearing broilers in cages in order to increase the number of birds being housed per square unit of building space, eliminate litter material, and increase labor efficiency.

Research is being conducted to solve problems associated with rearing broilers in cages. These problems include: breast blisters, leg weakness, brittle bones resulting in broken wings, enlarged feather follicles, and cannibalism. Most of these conditions have been experienced with floor-reared broilers but to a lesser degree.

Most cages house 10 to 12 birds allowing about 0.045 m^2 (0.5 ft^2) per bird. By stacking the cages three or four high, bird density can be increased considerably. Researchers have reported that breast blisters can be reduced by the use of a plastic fabric floor. Problems associated with skeletal weaknesses (primarily leg weaknesses) may be solved by the utilization of a diet specially formulated for raising broilers in cages. It is quite possible that poultry breeders could develop a bird which is specially adapted to a cage environment. Debeaking can be used as a means of controlling cannibalism.

Tests have been conducted with a specially fabricated cage in which the broilers are both grown and then shipped to the processing plant. To date, results from these tests are inconclusive.

Table 1 shows the space necessary in broiler housing to properly accommodate floor, feed, and water requirements.

TABLE 1 - Floor, Feed and Water Space Requirements - Broiler Housing

Type of Bird	Floor Space (per bird)	Feeding Space (per bird)	Watering Space (per 100 birds)
Broilers			
2 wk (.25 kg)	0.04 m^2	2.5 cm	75 cm
8 wk (1.7 kg)	0.07 m^2	7.5 cm	150 cm (trough)
Roasters			
11 wk (3 kg)	0.09 m^2	7.5 cm	150 cm (trough) 100 cm (circular)

NOTE: Table A1 in Appendix A contains the same information in imperial units of measurement.

B. MANURE SYSTEM

Most manure systems involve the simple cleaning of the entire floor area with a tractor blade or front-end loader. Deep-litter pits or shallow scraper pits are used in cage rearing operations.

Litter is removed from floor barns after every flock. Some operators are attempting to raise several flocks on the same litter by using strong disinfection procedures. Odor levels and disease potential increase, offsetting the cost of removal and new litter.

The removed litter should be spread on cultivated land and incorporated as soon as possible. Odor problems associated with broiler litter are usually not of great concern.

C. HEATING AND VENTILATION

The heating system used in most broiler barns is the hot water boiler and 50 mm (2 in.) black iron pipes previously described.

The pipes are usually hung on one wall, running the length of the barn at about 200 to 300 mm oc (8 to 12 in. oc) as shown in Figure 15.

Zone brooding with a hot water system should be used to conserve fuel. This might be achieved in a number of ways:

1. Having the *panels* of black iron pipe adustably suspended from the ceiling (lowered for brooding, raised for general heating) as shown in Figure 16.

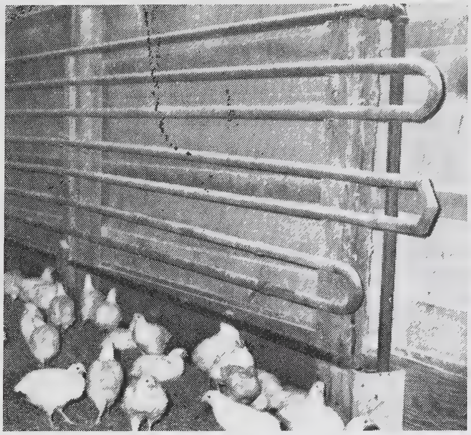


Figure 15 - Hot water pipes hung on the wall

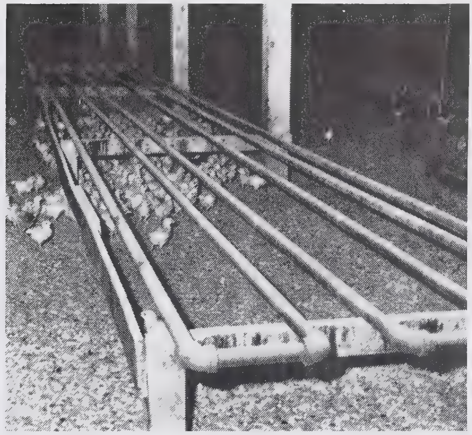
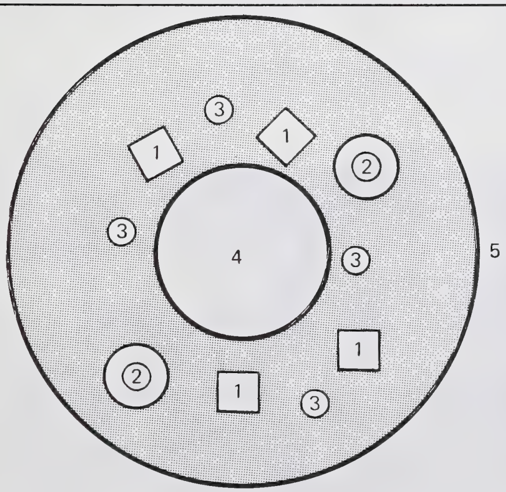


Figure 16 - Hot water pipes suspended horizontally

2. Installing cross-overs and control valves in the wall-hung heat pipes to provide maximum heat only in one-half the barn. In conjunction with this, a plastic curtain or insulated fold-down panels could be installed across the barn to reduce the barn heat loss (during brooding) by about 40% (Figure 17).

Gas fired hooded brooders are also used. A typical hooded brooder arrangement is shown in Figure 18. As the birds get older, these brooders are raised and can provide the total heat for the barn or be backed up by another heating system. Because of open-flame combustion, the extra moisture which they add to the building then becomes a disadvantage. They can be a fire hazard if they are not maintained and operated carefully. Ventilation systems are typically those described earlier.



1. Cardboard feeders
2. Hanging feeders
3. Water jars
4. Brooder
5. Brooder guard

Figure 18 - Brooder arrangements

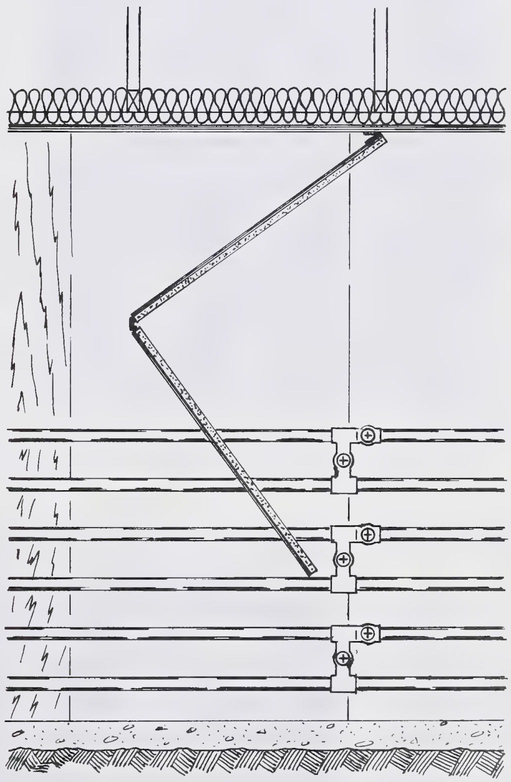


Figure 17 - Drop panels or curtains and hot water pipe crossovers for partial room brooding

The minimum ventilation rates given in Table 2 are the rates required for the removal of moisture from the broiler barn. According to various literature sources, this rate does not appear to be adequate to control ammonia gas build-up in the barn. The ventilation rate required to keep the ammonia level below 35 ppm (which is the 8-hour ammonia exposure limit for humans) would have to be nearly double the minimum ventilation rates given. Some researchers (Scarborough 1957 and Lillie 1970) suggest that growth rate and feed efficiency are not *critically* affected at ammonia concentrations less than 100 ppm. Work completed by L.E. Carr, University of Maryland, in 1977 concurs with this, showing that at these two concentration levels, growth rate, feed efficiency, mortality, and eye lesion problems are slightly improved at the lower ammonia levels (higher ventilation rates). Concentrations were not a problem at either level. The cost of maintaining barn temperature at the higher ventilation rate exceeds any return benefit associated with the lower ammonia levels by about two times. For practical reasons, ventilation levels are closer to the rates given.

Winter ventilation rates in negative pressure systems are usually so low that air circulation and mixing can be inadequate. This can be improved by hanging at least two circulating fans from the ceiling. These fans set up an air circulation pattern within the barn and help eliminate drafts, dead air pockets, and temperature stratification.

TABLE 2 - Ventilation and Heating Requirements for Broilers[1]

Age of Bird	Ventilation Rate (L/s per bird)			Supplemental Heat (watts/bird)			
	Winter	Spring/Fall	Summer	-37°C	-34°C	-32°C	-29°C
Brooding — Full Room	Infiltration[2]	0.02	0.05	6.8	6.6	6.4	6.2
Brooding — Half Room				4.8	4.6	4.3	4.1
2 Weeks (0.25 kg)	0.02	0.07	0.48	3.7	3.5	3.3	3.0
8 Weeks (1.7 kg)	0.14	0.48	2.4	7.1	6.5	5.9	5.3
11 Weeks (3 kg)	0.29	0.96	3.6	13.9	13.1	12.0	11.2

1. Ventilation and heating requirements are calculated on the basis of maintaining barn temperatures at 35°C and 70% RH for brooding, 29°C and 80% at 2 weeks of age 21°C and 80% RH at 8 weeks of age and 16°C and 80% RH at 11 weeks of age. Barn construction is RSI 3.5 insulation in walls and ceiling, with RSI 1.4 perimeter foundation insulation. These rates are also based on maintaining the litter inside the barn at 35% moisture content.
2. Infiltration rate of air is taken as less than one-third air change per hour.

NOTE: If hooded gas-fired brooders are used, the ventilation rates for birds older than 2 weeks should be increased by about 7% and the supplemental heat requirements should be increased by about 15% to compensate for the additional moisture added by the brooders.

NOTE: Table A2 in Appendix A contains the same information in imperial units of measurement.

D. LIGHTING

Rows of 40 watt incandescent lamps spaced 4 m oc (13 ft oc) are a common type of installation. Although there are a number of lighting programs for broiler houses, most broilers are grown under continuous light from one-day-old to slaughter age. This lighting method is somewhat hazardous, however, because in a power failure the flock could panic when confronted with total darkness for the first time. Therefore, it is good practice to provide at least one hour of darkness each day from two days of age to the end of the growing period.

Recently, some interest has been shown in using continuous light the first week followed by an intermittent lighting program (such as three hours of light followed by one hour of darkness) for the remainder of the growing period. To use an intermittent lighting program effectively, it is essential that the building be blacked out to prevent entry of light through doors or ventilation openings. If you are using a continuous lighting program with good results, do not switch from it without first consulting a poultry specialist.

Most broilers are maintained on fairly high light intensity of 10 to 20 lux (1 to 2 foot candles, which is equivalent to 40 to 80 watts per 18 m^2 of floor area) the first week, so that young chicks will be able to locate feed and water readily. This may be followed by low light intensity of 5 lux (0.5 foot candles or 15 watts per 18 m^2) to reduce power costs and prevent cannibalism. Often, growth of broilers is better under low-intensity light. However, it is important to have good light distribution so that feeders and waterers are adequately lighted. Light intensity can be controlled by using commercial-type *rheostats*. Rheostats should be disconnected from the electrical circuit when the building is being washed out.

Incandescent bulbs are considered superior to other light sources. Bright white light may contribute to feather picking, which can lead to cannibalism.

E. FEEDING AND WATERING SYSTEMS

For brooding chicks, besides the regular feeding system, cardboard feed trays and extra water jars should be placed within the brooding zone to ensure all chicks have access to both. They are gradually removed over the first 4 to 6 days as the chicks locate the automatic feeding system.

The usual feeding system used for broilers is the suspended automatic *chain and trough feeder* or the suspended automatic *chain and pan feeder* system (Figure 19). These systems normally make a complete circuit within the broiler barn, ensuring that enough feeder space is available if the birds are on full feed. If a restricted feeding program is used, then additional feeder space has to be provided.

Waterers are usually the hanging automatic bell type (Figure 20) or the automatic trough type (Figure 21). Hanging water cups (Figure 22) are also available for floor or cage reared broilers. An ample, clean source of water is required. Birds have no stomach so their water retaining capacity is very low. They must drink freely and often as they require 0.9 to 1.4 kilograms (2 to 3 lb) of water to efficiently utilize 0.45 kilograms (1 lb) of feed. The water source should be low in minerals and particularly low in salt as excess salt leads to watery droppings and consequently wet litter.

Both feeding and watering facilities need to be arranged so that a bird will not have to travel further than 3 m (10 ft). Both systems are suspended from the ceiling by cable winch and rope so they can be elevated for tractor clean-out.

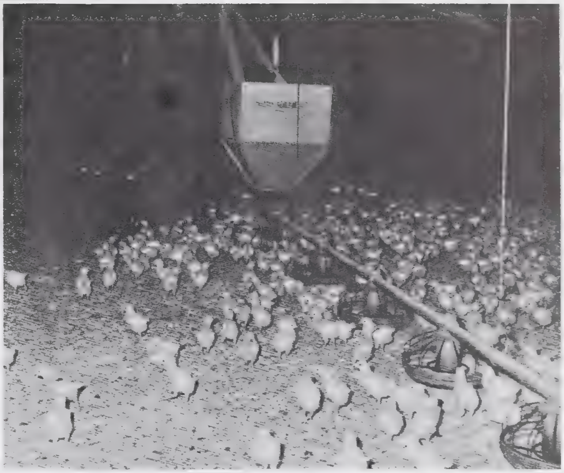


Figure 19 - Mechanical feeder, suspended from the ceiling

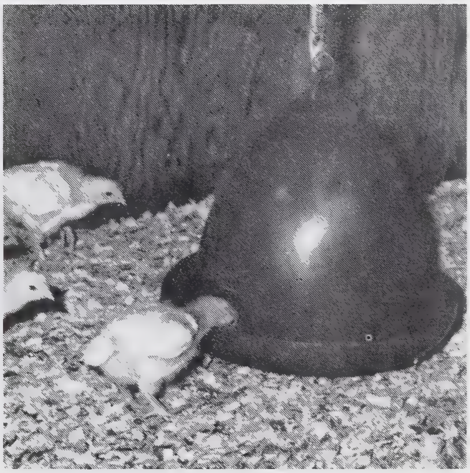


Figure 20 - Bell type automatic waterer

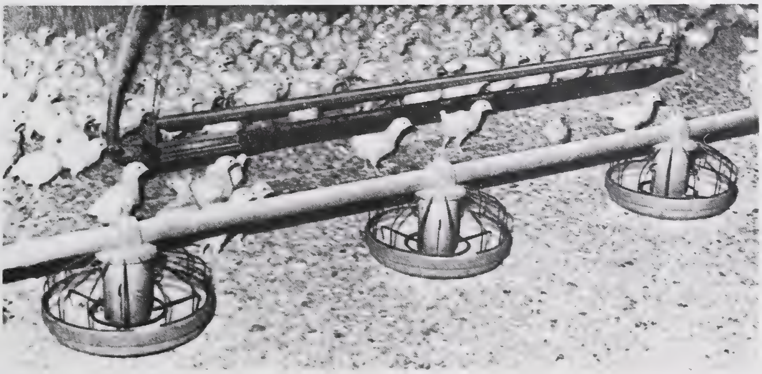


Figure 21 - Automatic watering trough (and part of a mechanical feeder)

Figure 22 - Hanging water cup

BREEDER FLOCKS

A. BARN CONSTRUCTION

Breeder barns are generally of pole-frame or stud wall construction, 11 to 12 m (36 to 40 ft) wide. A general layout is shown in Figure 23.

Table 3 shows the floor, feed, and water space requirements needed for breeder flocks.

B. MANURE SYSTEM

Most breeder barns have solid manure systems. This either involves a total litter system similar to broiler barns, or a 1/3 litter, 2/3 slatted floor, or a totally slatted floor. The litter areas are either packed clay or concrete. The manure storage under the raised slatted areas are either shallow or deep pits. These areas are cleaned either by raising the slats in a shallow pit or by driving under the slats with the cleaning unit. For easy clean-out, the pit area should be made of concrete.

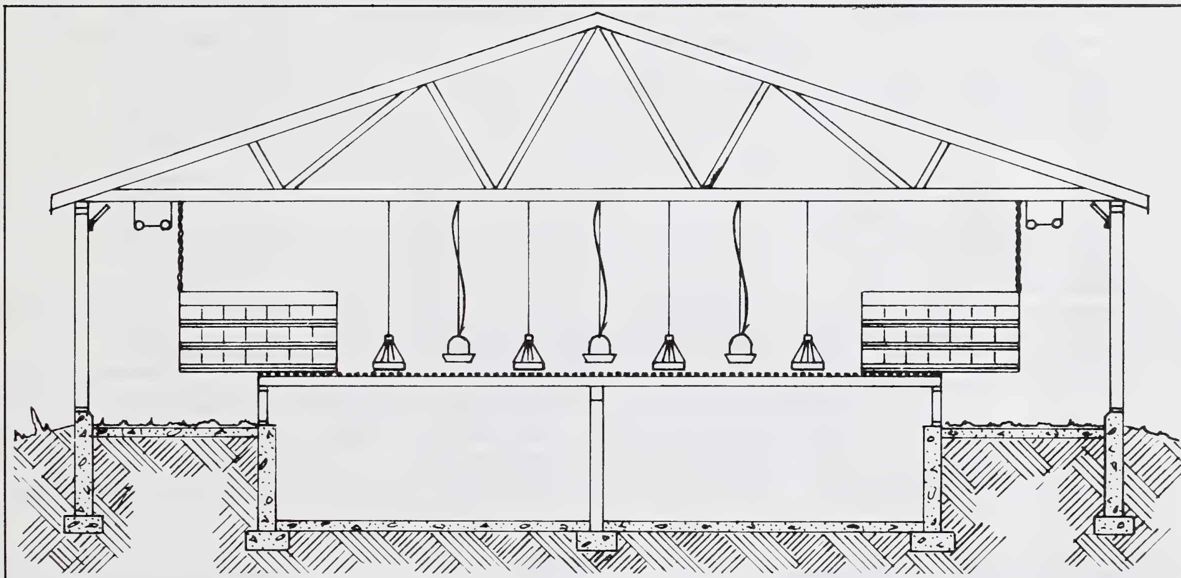


Figure 23a - Breeder barn layout with center slats

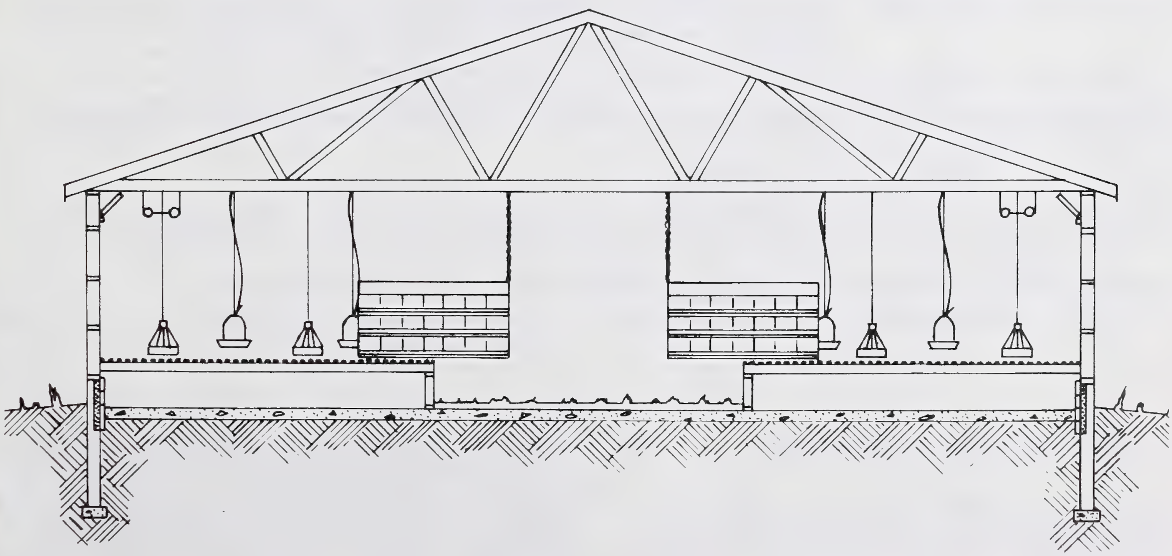


Figure 23b - Breeder barn layout with side slats

TABLE 3 - Floor, Feed and Water Space Requirements - Breeder Flocks

REPLACEMENT PULLETS

Age & Type of Bird	Floor Space (per bird)	Feeding Space (per bird)	Watering Space (per 100 birds)
0 - 2 weeks	0.05 m^2	2.5 cm	two 4L fountains
2 - 8 weeks	0.07 m^2	5 cm	150 cm (trough) 100 cm (fountains)
8 - 20 weeks	0.14 m^2 (light breeds) 0.19 m^2 (heavy breeds)	7.5 cm	150 cm (trough) 100 cm (fountains)

LAYING FLOCK

	Floor System		
	Deep Litter Floor Dropping pits Under Roosts	Combination 1/2 - 2/3 Wire or Slat Floor 1/2 - 2/3 Deep-Litter Floor	Complete Wire or Slat Floor
Floor Area per Hen:			
egg-strain breeds	0.186 m^2	0.093 m^2	0.046 m^2
heavy breeds (over 2.27 kg)	0.279 m^2	0.140 m^2	0.093 m^2
Feeding Space per 100 Hens:	If hand fed 6000 mm of double-sided troughs or 4 round hanging feeders (pan diameter 400 mm). For automatic feeding reduce feeding space 50 percent.		
Watering Space per 100 Hens:	2 watering cups, two 22 litre fountains of 1500 linear mm of drinking troughs.		
Nesting Space per 100 Hens:	20 nests, 250 x 300 x 300 mm or 300 x 300 mm for light and heavy breeds respectively or		

NOTE: Table A3 in Appendix A contains the same information in imperial units of measurement.

C. HEATING AND VENTILATION

The heating and ventilation systems for brooding and growing of breeders are the same as for broilers. In-barn circulating fans can be used in both growing and breeding barns to improve air circulation patterns especially in the winter.

The most common heating system used in laying barns is hot water boiler and black iron pipe. The rows of pipes are hung from the ceiling in front of the air inlets, hanging far enough from the ceiling to allow free air movement over them without interfering with the air flow. Ventilation and heating requirements for breeder flocks are shown in Table 4.

TABLE 4 - Ventilation and Heating Requirements for Breeder Flocks[1]

Type of Bird	Ventilation Rate (L/s per bird) Winter	Spring/Fall	Summer	Supplemental Heat (watts/bird) -37°C	-34°C	-32°C	-29°C
REPLACEMENT PULLETS							
Full Room				6.8	6.6	6.4	6.2
Brooding	Infiltration[2]	0.02	0.05				
Half Room				4.8	4.6	4.3	4.1
2 Weeks	0.02	0.07	0.48	3.7	3.5	3.3	3.0
8 - 20 Weeks	0.19	0.71	2.4	13.7	13.0	12.0	11.2
LAYING HENS							
Light Breeds							
- on litter				13.7	13.0	12.0	11.2
- on partial slats	0.19	0.71	2.9	10.8	10.2	9.3	8.7
- on slats				9.3	8.8	8.1	7.5
Heavy Breeds							
- on litter				19.7	18.7	17.3	16.2
- on partial slats	0.29	0.95	3.6	15.3	14.5	13.3	12.4
- on slats				13.9	13.1	12.0	11.2

1. Ventilation and heating requirements are calculated on the basis of maintaining barn temperatures and relative humidities of 35°C and 70% RH for brooding, 29°C and 80% at 2 weeks of age 16°C and 80% RH for the other groups of birds. Barn construction is RSI 3.5 insulation in the walls and ceiling, with RSI 1.4 perimeter foundation insulation. These rates are also based on maintaining the litter inside the barn at 45% moisture content.

2. Infiltration rate of air is taken as less than one-third air change per hour.

NOTE: Table A4 in Appendix A contains the same information in Imperial units of measurement.

D. LIGHTING

Allow 24 hours of lighting the first three days of brooding and then reduce it by 1.5 hours per week, to 8 hours per day until they are 20 weeks old. One 25 watt incandescent lamp for every 21 m² (230 ft²) of floor area is adequate. This is accomplished by installing rows of lights about 5 m (16 ft) apart, with the outlets spaced 5 m apart in the rows and staggered with the adjacent row.

If using fluorescent lighting, two rows of single 25 watt fluorescent lamps should be spaced about 6 m (20 ft) apart.

Lighting circuits should be controlled by a time clock.

E. FEEDING AND WATERING SYSTEMS

These systems in the brooding and growing barn are the same as in the broiler barn. However, if a skip-a-day feeding program is being used, feeder space must be increased to allow all of the birds to feed at the same time. This requires at least 10 cm (4 in) of trough space per bird. Even feed distribution to all the birds is desired in breeder flocks. This requires either a very rapid feeding system or one in which all the pans are filled and then the feed is released to the birds at the same time.

The feeding and watering facilities in the laying barns are located on top of the slats in partially or fully slatted facilities.

F. NESTS

Two-tier individual nests 300 x 300 x 300 mm, (12 x 12 x 12 in), (Figure 24) are preferred and should be placed at right angles to the slats. They can either be even with the edge of the slats, or hanging over the litter areas. This facilitates easy access by both the birds and the egg collector. Provide one nest for four birds.

Community nests (Figure 25) 600 mm x 1200 mm (24 in. x 48 in.) suitable for 50 birds, may also be used.

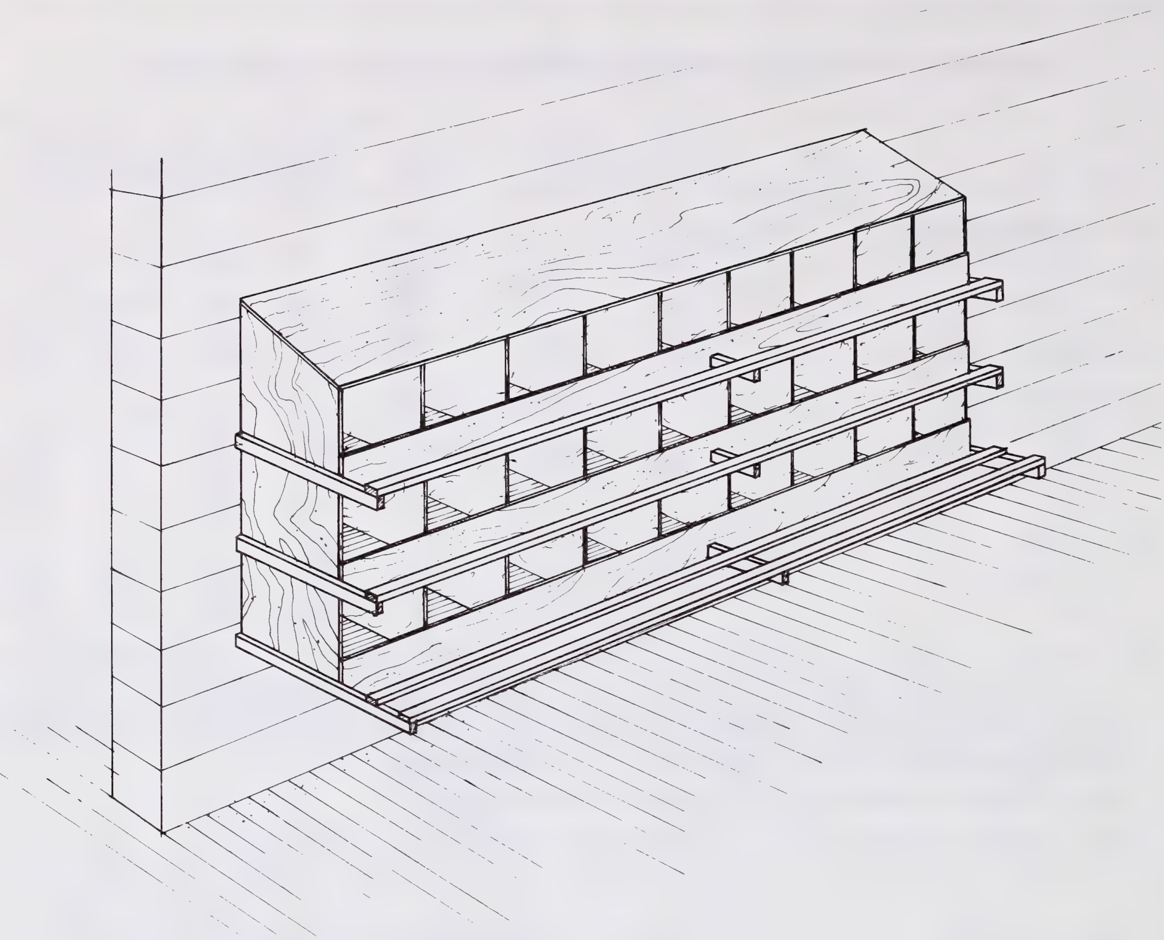


Figure 24 - Three tier individual nest boxes (C.P.S. plan no. 5015)

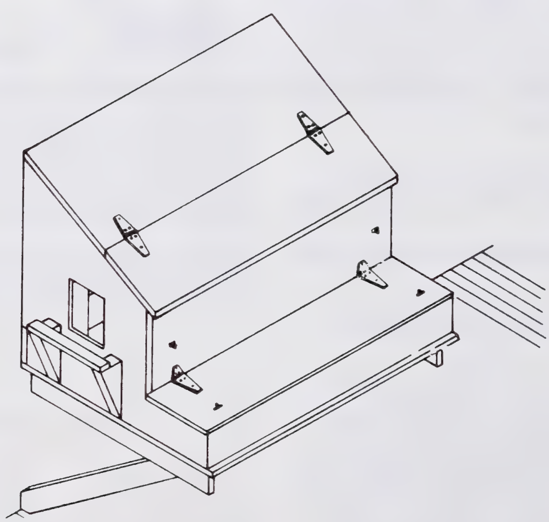


Figure 25 - Community nests (C.P.S. plan no. 5016)

LAYING FLOCK

A. BARN CONSTRUCTION

Pole-frame or stud wall buildings are most commonly used for laying barns. These are either *single storey* (Figure 26) or *double storey* (Figure 27) structures that utilize the lower half of the building for manure storage.

Small barns for floor operations are typically laid out as shown in Figure 28. Individual or community nests may be used. See fact sheet 722-4 *Planning Considerations - Small Poultry Flock Housing.*

Barns for replacement pullets are either *floor rearing* barns, 11 to 12 m wide (36 to 40 ft), similar to broiler ar to barns, or a *two to four row cage rearing* barn. The 'he cages are usually *flat deck* style cages to accommodate even-brooding conditions, although two-tier cage systems are available.

Cage laying barns are usually built wide enough to accommodate two to six rows of cages. This is dependent on the size of the flock, the style of the cage used, whether hand feeding and egg collection are used, and whether the barn is to be sectioned off into several rooms to accommodate continuous egg supply rather than an all-in all-out type of operation. A major consideration before finalizing building width, length, and height is to decide on

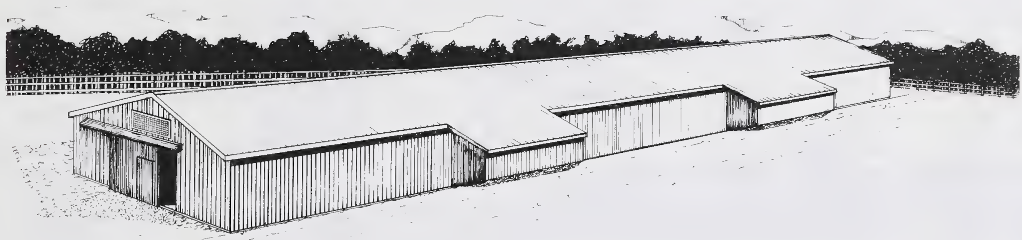


Figure 26 - Single storey caged layer barn (C.P.S. plan no. 5212)

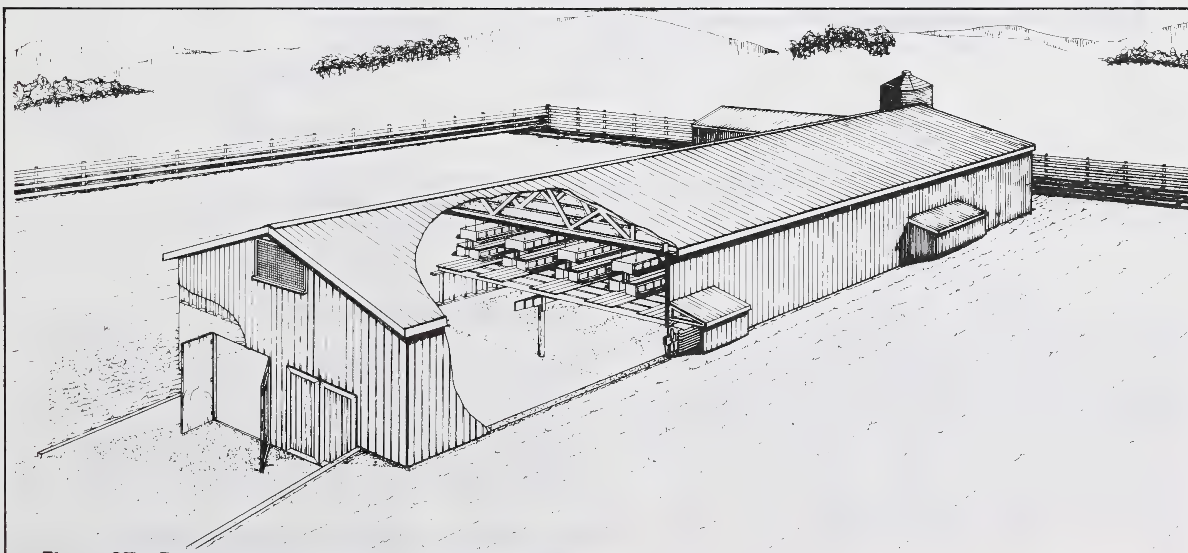


Figure 27 - Deep pit caged layer barn (C.P.S. plan no. 5211)

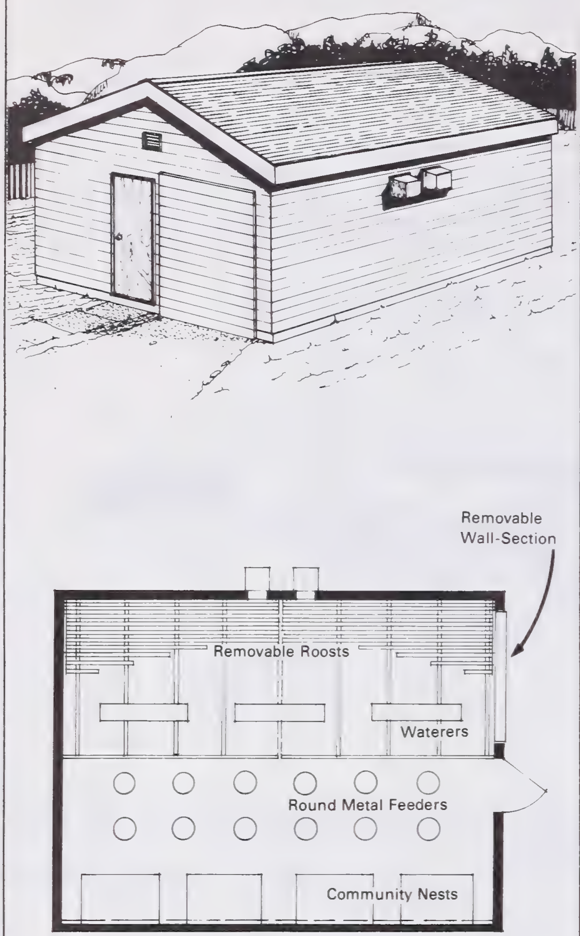


Figure 28 - Small poultry barn for floor operations (C.P.S. plan no. Q5110)

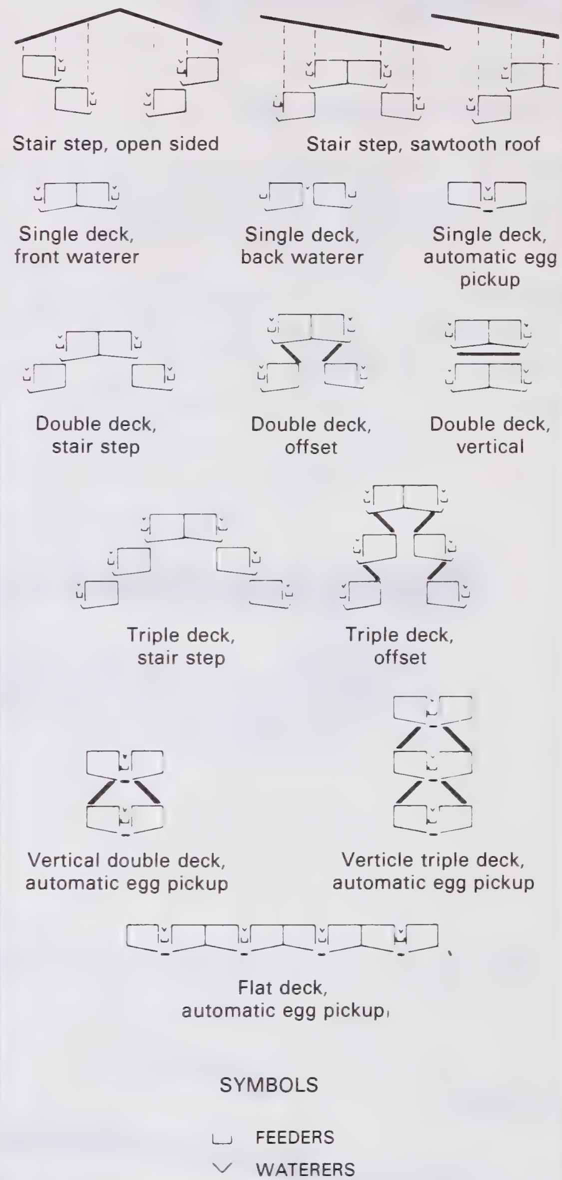


Figure 29 - Cage styles and layouts

the style of cage row to be used. Figure 29 indicates some of the various cage styles. The height of the cages, width of the cages, number of cage rows required, and number and width of alleys, need to be determined before a building can be selected. Stronger walls and trussed rafters are also required if ceiling suspended cages are to be used.

Table 5 outlines the floor, feed, and water space requirements needed for laying flocks.

B. MANURE SYSTEMS

In floor operations, the litter area can be cleaned frequently, or more straw or shavings can be added until the litter depth is 30 cm (12 in.). As long as the litter remains dry, clean out of the barn is not required. The manure area under the slatted portion of a floor laying operation need only be cleaned out once or twice per flock.

Cage laying operations typically have two manure handling options. In single storey barns, there are concrete trenches

TABLE 5 - Floor, Feed & Water Space Requirements for Laying Flocks

FLOOR HOUSING (SMALL COMMERCIAL OR HOBBY) FOR BROODING AND REPLACEMENT PULLETS

Age & Type of Bird	Floor Space (per bird)	Feeding Space (per bird)	Watering Space (per 100 birds)
0 - 2 weeks	0.05 m^2	2.5 cm	2 - 4L fountains
2 - 8 weeks	0.07 m^2	5 cm	150 cm (trough) 100 cm (fountains)
8 - 20 weeks	0.14 m^2 (light breeds) 0.19 m^2 (heavy breeds)	7.5 cm 100 cm (fountains)	150 cm (trough)

FLOOR HOUSING FOR LAYING FLOCKS

	Floor System		
	Deep Litter Floor Dropping pits Under Roosts	Combination 1/2 - 2/3 Wire Or Slat Floor 1/2 - 2/3 Deep-Litter Floor	Complete Wire or Slat Floor
Floor Area per Hen:			
egg-strain breeds	0.186 m^2	0.093 m^2	0.046 m^2
heavy breeds (over 2.7 kg)	0.279 m^2	0.140 m^2	0.093 m^2

Feeding Space per 100 Hens:	If hand fed 6000 mm of double-sided troughs or 4 round hanging feeders (pan diameter 400 mm). For automatic feeding reduce feeding space 50 percent.
Watering Space per 100 Hens:	2 watering cups, two 22 litre fountains of 1500 linear mm of drinking troughs.
Nesting Space per 100 Hens:	20 nests, 250 x 300 x 300 mm or 300 x 300 x 300 mm for light and heavy breeds respectively or 2 community nests 600 mm by 1200 mm.

CAGE HOUSING

	Cage Space (per bird)	Feed Space (per bird)	Water Space (per cage)
Brooding & Replacement Pullets			
0 - 6 weeks	0.016 m^2	25 mm	15 birds per nipple 25 birds per cup
6 - 18 weeks	0.029 m^2	50 mm	8 birds per nipple 12 birds per cup
18 + weeks	0.039 m^2	50 mm	8 birds per nipple 12 birds per cup
Laying Flock			
1.6 kg bird	0.041 m^2	100 mm	1 water cup per cage or 1 per 2 cages
2.0 kg bird	0.046 m^2	100 mm	depending on cage design.

NOTE: Table A5 in Appendix A contains the same information in imperial units of measurement.

225 mm to 300 mm (9 to 12 in.) deep under the cage rows. Manure is scraped in these with either automatic gutter cleaners or by a small tractor scraper. (Tractor scraped gutters require a suspended cage system). The manure is moved to one end of the barn where it is either stored as a liquid in a large concrete manure tank, or transferred to a lagoon. In some cases, it is handled as a semi-solid and immediately elevated outside to a manure spreader where it is spread on the land. The *liquid manure system* (concrete tank or lagoon) has to be agitated and handled through a liquid manure spreader tank. Water is usually added to the manure gutters 24 hours before clean-out to facilitate scraping. More water is added in a liquid manure system than in the manure spreader system. Owing to its sticky consistency, a large power unit is required to handle the manure if no water is added to it.

Another alternative for a *dry manure system* utilizes endless manure belts under the cages; the manure is conveyed to one end of the barn, dumped onto a cross conveyor, and elevated outside to the manure spreader. Another system uses a *scraper* or an *auger scraper.* The manure is scraped off the manure boards down on to a narrow barn cleaner or into a deep pit under the cages.

In two storey or *deep litter* cage operations, the manure drops into the lower storey and is stored there for at least one laying flock. The ventilation fans are installed in the walls below cage level so that air flow goes down through the cages, across the top of the stored manure, and out the fans. This air movement is usually adequate to create a dry manure product that can be cleaned out with a front end loader. Additional circulation can be provided by circulation fans hung below the cages. This type of manure storage requires good quality water low in salts if the droppings are to remain dry enough to stay in a manure *pile.* Leaking waterers also create wet manure conditions and must be corrected if the manure storage is to remain dry and at low odor levels.

C. VENTILATION AND HEATING

Heating systems for replacement pullets raised on the floor are similar to those used in broiler barns. Hot water pipes on top of each row of cages can be used for brooding and growing pullets in a large cage rearing system. The total amount of heat required can be reduced in this style of brooding because the chicks are closer to the heat source.

Many laying operators have been willing to accept colder barn temperatures, increased feed consumption, and slightly lower egg production rather than install supplemental heating in their barns. They feel that the few extremely cold days which result in poorer barn conditions do not warrant the cost of installing a heating system. However, optimum laying conditions do require supplemental heat and if moisture levels and odor levels are to be minimized, a significant amount of supplemental heat should be added.

Forced air heating systems are probably the most practical systems in floor layer operations from a cost standpoint because of the smaller barn size and lower number of birds. These systems must be properly installed as described previously.

The most common heating system in a large cage laying barn is the hot water boiler and black iron pipe. The pipes are placed in front and below the incoming fresh air inlets. Ventilation systems are usually the common negative pressure system with air inlets down the outside wall of the barn. In two-room barns, air inlets in the middle of the barn are fairly common. Management of this type of system can be critical in that different ventilation rates from one side to the other may result in one side actually starving the other side of air. A *divider* board or wall in the attic may be required to prevent this short circuiting of air.

In Table 6, both the ventilation and heating requirements for laying flocks are outlined.

D. FEEDING AND WATERING SYSTEMS

In floor operations, the least expensive method of feeding is *hand feeding* using small self-feeders. Water is usually supplied in automatic troughs or fountains, or in hand filled fountains.

In cage operations, feeding is either by means of automatic chain feed troughs or by hand filled troughs the length of the cage row. The water system is either a continuous flowing trough or the more commonly used water cups which are under low pressure. All watering systems require a filter to prevent plugging of the float valves within the system. A pressure reducer is also required to operate most cage watering systems.

E. LIGHTING

For floor laying operations, rows of 40 watt incandescent lamps 4 m (13 ft) on centre with the lamps in each row staggered and spaced 6 m (20 ft) apart, are suggested. These should be on a dimmer and time clock. For cage operations, 25 watt lamps, 4 m (13 ft) on centre down the walk aisles are suggested for flat deck or double tier cage systems and every 3 m (10 ft) between triple or four tier cages. These should also be controlled by a dimmer and time clock. A convenience outlet should be provided every 30 m (100 ft) around the perimeter in the floor laying operation and down each alley in a cage laying barn.

Many egg producers are interested in total light control to ensure maximum egg production. This requires tight building construction and light traps over the exhaust fans (Figure 30).

The following are some general lighting programs for laying flocks. In these programs, a light intensity of 5 lux (0.5 foot candle) is equivalent to about 15 watts per 18 m^2. These intensities can be achieved by the spacings noted previously. The following lighting conditions are required for houses with light control and without light control.

TABLE 6 - Ventilation and Heating Requirements for Laying Flocks[1]

Type of Bird	Ventilation Rate (L/s per bird) Winter	Spring/Fall	Summer	Supplemental Heat (watts/bird) -37°C	-34°C	-32°C	-29°C
REPLACEMENT PULLETS							
Brooding — Full Room	Infiltration[2]	0.02	0.05	6.8	6.6	6.4	6.2
Brooding — Half Room				4.8	4.6	4.3	4.1
2 Weeks	0.02	0.07	0.48	3.7	3.5	3.3	3.0
8 - 20 Weeks	0.19	0.71	2.4	13.7	13.0	12.0	11.2
CAGED REARED[3]							
Brooding	Infiltration	0.02	0.05	4.8	4.6	4.3	4.1
2 weeks	0.02	0.07	0.48	3.7	3.5	3.3	3.0
8 - 20 weeks	0.09	0.71	2.4	4.8	4.3	3.8	3.3
LAYING HENS							
Floor Laying	0.19	0.71	2.9	13.7	13.0	12.0	11.2
Cages (deep pit)	0.24	0.95	3.3	9.3	8.8	8.1	7.5
Cages (shallow pits)[3]	0.14	0.95	3.3	5.3	4.9	4.3	3.8

1. Ventilation and heating requirements are calculated on the basis of maintaining barn temperatures and relative humidities of 35°C and 70% RH for brooding, 29°C and 80% at 2 weeks of age and 16°C and 80% RH for the other groups of birds. Barn construction is RSI 3.5 insulation in the walls and ceiling with RSI 1.4 perimeter foundation insulation. These rates are also based on maintaining the litter inside the barn at 45% moisture content if manure is stored for more than one week.
2. Infiltration rate of air is taken as less than one-third air change per hour.
3. Manure is removed from the barn every week. No attempt is made to dry the litter inside the barn.

NOTE: Table A6 in Appendix A contains the same information in British units of measurement.

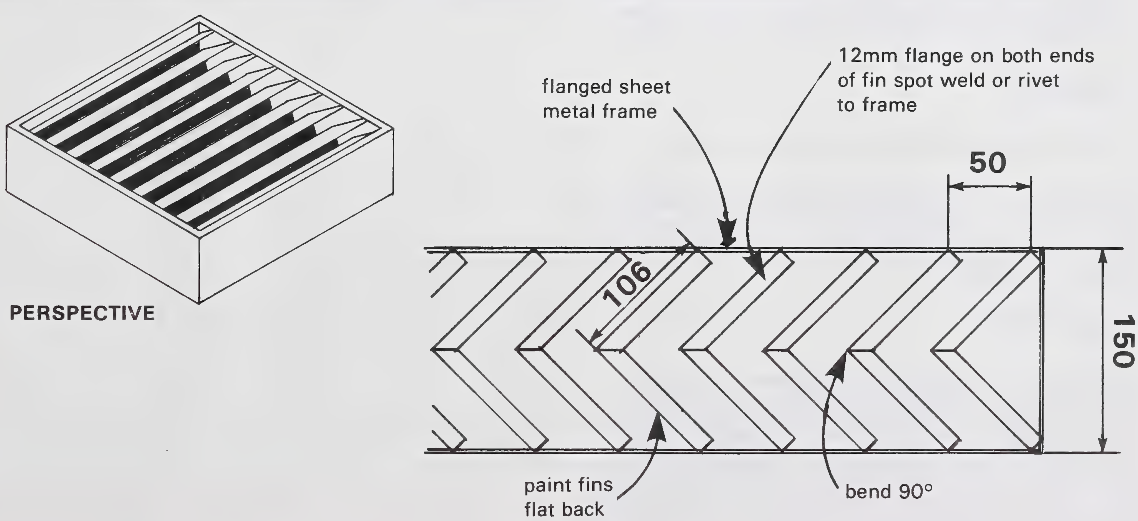


Figure 30 - Light trap for ventilation fans

1. LIGHT CONTROL HOUSES

Growing:

- 23 hours of bright light for the first 3 to 7 days (about 11 lux or 1 foot candle).
- 1 to 20 weeks require 8 to 10 hours of low intensity light (about 3 to 5 lux or 0.3 to 0.5 foot candle).
- at 20 weeks, increase intensity of light to 12 to 13 hours (about 11 lux or 1 foot candle).

Laying:

- increase lighting at regular intervals by 15 to 20 minutes until 17 hours is reached.
- at 28 to 33 weeks use about 11 lux or 1 foot candle.

2. HOUSES WITHOUT LIGHT CONTROL

- 23 hours of bright light for the first 3 to 7 days (11 lux or 1 foot candle).
- *in-season hatch*, from April 15 to September 1, when hatches grow on natural light; such hatches will be under a natural step-down light program.
- *out-of-season hatch*, from September 1 to April 15, where extra light should be used at time of hatching. This should then be stepped-down 15 minutes per week until natural day length at the age of 20 weeks.

OR

- determine the length of the longest day between 1 week and 20 weeks. Use artificial lights until the longest day is reached; then turn the lights off.
- never decrease the period or intensity of light.
- at 20 weeks, increase the light to at least one hour over dawn and dusk light.
- from 20 to 26 weeks the light should be increased to bring the day length up to the greatest total day length the flock will experience during the laying period. The flock should be continued at that day length throughout the laying cycle.

F. CAGES

1. BROODING AND REPLACEMENT PULLETS

These cages are finer meshed wire cages with a capacity for 20 to 50 chicks, depending on the equipment design. Easy access to the cages is important for vaccinations and debeaking procedures.

2. LAYING FLOCK

Laying cages are available in many different styles with different feeding, watering, egg collection, and manure systems. Some are shown in Figure 29. Cages must be designed for strength and durability. They can either be suspended from the ceiling or floor mounted. They must be designed so the eggs will not get caught at the back edge of the cage or in the wire mesh. Adequate feed and water space must also be considered.

G. EGG HANDLING

Good cage design is the first step to obtaining quality eggs. The egg conveyor belt must also carry the eggs smoothly and in single file. The egg elevators from higher tiers of cages must be well designed and adequately maintained to lower the eggs without increasing the speed. If cross conveyors are used, they must also be designed so the eggs do not bump into each other. Egg collection (either manual or mechanical) from the end of the egg conveyors, must be done with care to avoid cracking.

It is important to know that egg quality begins to decline as soon as the egg is laid. Good handling practices will slow this deterioration or at best, minimize it. Proper temperature and humidity are most important, therefore:

1. Have a separate, adequately-equipped egg room close to the laying flock.
2. Gather the eggs often - at least twice a day.
3. Gather the eggs in baskets or containers that will allow rapid cooling.
4. Cool to less than 13°C and above 7°C immediately after gathering.
5. Maintain air humidity as close to 70% as possible (this slows down moisture loss from the egg).
6. After chilling, pack the eggs with the small end down into fillers or flats placed in shipping cartons.
7. Market the eggs as often as possible.
8. Keep the egg room and transport vehicle free of *off-odors*.
9. Do not handle eggs or their shipping containers in a rough manner. Eggs are fragile and you can break shells or internal membranes, resulting in downgrading of an otherwise top quality egg.

A typical sizing for an egg cooler room is shown in Table 7.

TABLE 7 - Sizes for Egg Cooling Rooms

	1.67 Cases/100 Hens/Week			
Flock	3000-3600	3600-4200	4200-6000	6000-9600
Inside Size (Min.)	6 m^2	8.4 m^2	10 m^2	13 m^2
Cases (30 Doz.)	60	70	100	160
Refrigeration (kW-hrs)	1.4	1.5	2.1	3.0

NOTE: Table A7 in Appendix A contains the same information in imperial units of measurement.

TURKEYS

A. BARN CONSTRUCTION

Most of the new turkey broiler operations are constructing barns similar to chicken broiler barns: i.e. either concrete foundation, stud wall, clear-span truss rafter, or pole-frame, clean-span construction, 11 or 12 m (36 to 40 ft) wide. Some of the *semi-confinement* broiler or *heavy growing* barns are pole-frame construction. They have small fenced yards off to one side with a removable panel or curtain wall. This is used to close the building down for winter housing. Most of the breeding barns are total confinement barns identical to broiler barns. The toms are normally housed in a separate building of similar construction, although they can be housed in a portion of the hen barn.

In Table 8, space requirements for floor, feed, and water are shown.

TABLE 8 - Floor, Feed and Water Space Requirements - Turkeys

Type of Bird	Floor Space (per bird)	Feeding Space (per bird)	Watering Space (per bird)
Broilers			
Hatching to 8 weeks	0.09 m^2	50 mm	12 mm (or 35 poults/ 4 L fountain)
8 weeks to 14 weeks	0.14 m^2	75 mm	25 to 37 mm (or 2 to 4 automatic fountains/ 100 birds)
Heavies			
Hens (to 18 weeks)	0.37 m^2	75 mm	37 mm (4 automatic fountains/100 birds)
Breeding Flocks			
Light breeds			
Hens (to 13 lb)	0.28 m^2	75 mm	37 mm (4 automatic
Toms (to 20 lb)	0.46 m^2	75 mm	37 mm fountains/100 birds)
Heavy breeds			
Hens (to 17 lb)	0.37 m^2	75 mm	37 mm (4 automatic
Toms (to 28 lb)	0.56 m^2	75 mm	37 mm fountains/100 birds)
Nest space	1 nest per 5 hens, each 350 x 600 x 600 mm		
Broody space[1]	.046 m^2 of wire floor, no bedding, well lighted		
Range space	- 2400 birds per hectare/1000 birds per acre; moved each week - range shelters - 0.13 m^2 for small breeds - 0.17 m^2 for large breeds		

1. Area separate from breeding pen used to isolate "broody" breeder hens and restore egg production.

NOTE: Table A8 in Appendix A contains the same information in imperial units of measurement.

B. MANURE SYSTEM

All barns use a manure system which is cleaned out after every flock with a front-end loader.

C. VENTILATION AND HEATING

Heating and ventilation systems are the same for turkeys as for broiler chickens. Extra care must be taken to prevent drafts on turkey poults as they are very susceptible to temperature fluctuations. Ventilation and heating requirements for turkeys are listed in Table 9.

D. LIGHTING

Light intensity must be high enough to enable the poults to locate feeders and waterers. However, they should not be so intense as to promote toe and feather picking, because these habits can lead to cannibalism. In windowless houses, light intensity can be gradually reduced as the birds grow older (Table 10). Power-saving dimming devices are useful for this purpose.

Many satisfactory lighting programs are used commercially. In a typical schedule, light is provided continuously for the first 2 to 3 days, followed by 23 hours of light and 1 hour of darkness throughout the entire growing period. The hour of darkness serves to condition the birds to the darkness that would occur if the power failed. Results from recent experiments show that intermittent lighting may be superior to other types of lighting.

TABLE 9 - Ventilation and Heating Requirements for Turkey Flocks[1]

Type of Bird	Ventilation Rate (L/s per bird) Winter	Spring/Fall	Summer	Supplemental Heat (watts/bird) -37°C	-34°C	-32°C	-29°C
Broilers (or replacements)							
Brooding	Infiltration[2]	0.03	0.12	10.3	9.9	9.7	9.3
2 weeks	0.03	0.07	0.30	8.9	8.5	8.1	7.8
8 weeks	0.12	0.53	2.65	8.8	8.4	7.7	7.2
14 weeks	0.36	1.30	6.49	22.8	21.7	20.2	19.1
Heavies							
18 weeks (7.73 kg)	0.56	2.00	10.02	40.9	39.0	36.4	34.4
22 weeks (12.73 kg)	0.92	3.18	15.92	66.7	63.7	59.5	56.8
Breeder flocks							
Light breeds							
Hens (to 5.9 kg)	0.43	1.53	7.66	30.5	29.1	27.1	25.6
Toms (to 9.1 kg)	0.66	2.36	11.79	48.8	46.6	43.5	41.0
Heavy breeds							
Hens (to 7.73 kg)	0.56	2.00	10.02	40.9	39.0	36.4	34.6
Toms (to 12.73 kg)	0.92	3.18	15.92	66.7	63.7	59.5	56.2

1. Ventilation and heating requirements are calculated on the basis of maintaining barn temperature at 35°C and 70% RH for brooding, 29°C and 80% RH at 2 weeks of age, 21°C and 80% RH at 8 weeks of age and 16°C and 80% RH for all other categories of birds. Barn construction is RSI 3.5 insulation in walls and ceiling with RSI 1.4 perimeter foundation insulation. These rates are also based on maintaining the litter inside the barn at 45% moisture content.

2. Infiltration rate of air is taken as less than one-third air change per hour.

NOTE: Table A9 in Appendix A contains the same information in imperial units of measurement.

E. FEEDING AND WATERING SYSTEMS

To maintain feed consumption, the poults must have easy access to the feeders. A bird should not have to walk more than 3 m (10 ft) to a feeder. During the first few days, place the feed on new cardboard trays. Provide two feed trays for each 100 poults. The box in which the poults were shipped may be cut down and used as a feeder. Regular feeding equipment should be introduced by the end of the third day, or it may be used along with feed trays from the start. Remove the feed trays after the poults are eating from the regular feeding equipment. Adjust the lip of the trough to the level of a bird's back. Many kinds of mechanical feeders are available. They are similar to other poultry feeders but are of heavier gauge and size for turkeys.

When poults are first placed under brooders, dip the beaks of some of the birds to familiarize them with the water and its location. This will prevent the birds from dying of thirst. Of the automatic waterers available, the *bell-shaped* ones are most often used to complement the founts. The founts should remain in the pen until the poults are accustomed to the automatic waterers. Make sure that all poults find the waterers when the founts are removed. Disinfect the waterers two or three times a week with an iodine based disinfectant. Adjust the level of the waterer frequently to ensure that it is level with a bird's back.

F. NESTS

The nests for breeding hens are very similar to the individual breeding nests for chickens except they are larger (see Table 8 and Figure 24). These nests are usually mounted against the perimeter walls.

TABLE 10 - Light Intensity Schedule (1976)

AGE (days)	INTENSITY (lux)
1-5	35
6	30
8	25
10	20
12	15
14	10
16	5
18	2
20	1
22+	0.4

APPENDIX

TABLE A1 - Floor, Feed and Water Space Requirements - Broiler Housing

Type of Bird	Floor Space (per bird)	Feeding Space (per bird)	Watering Space (per 100 birds)
Broilers			
2 wk (0.5 lb)	0.5 ft^2	1 in.	30 in.
8 wk (3.7 lb)	0.7 ft^2	3 in.	60 in. (trough) 40 in. (circular)
Roasters			
11 wk (6.5 lb)	1 ft^2	3 in.	60 in. (trough) 40 in. (circular)

TABLE A2 - Ventilation and Heating Requirements for Broilers[1]

Type of Bird	Ventilation Rate (cfm per bird)			Supplemental Heat (BTUh/bird)			
	Winter	Spring/Fall	Summer	-35°C	-30°C	-25°C	-20°F
Brooding – Full Room	Infiltration[2]	0.05	0.1	23.2	22.5	21.8	21.2
Brooding – Half Room				16.4	15.7	14.7	14.0
2 wk (0.5 lb)	0.05	0.15	1.0	12.6	11.9	12.3	10.2
8 wk (3.7 lb)	0.30	1.0	5.0	24.2	22.2	20.1	18.1
11 wk (6.5 lb)	0.60	2.0	7.5	47.5	44.7	41.0	38.2

1. Ventilation and heating requirements are calculated on the basis of maintaining barn temperatures at 35°C and 70% RH for brooding, 84°F and 80% RH at 2 weeks of age, 70°F and 80% RH at 8 weeks of age and 60°F and 80% RH at 11 weeks of age. Barn construction is R20 insulation in walls and ceiling with R6 perimeter foundation insulation. These rates are also based on maintaining the litter inside the barn at 35% moisture content.

2. Infiltration rate of air is taken as less than one-third air change per hour.

NOTE: If hooded gas-fired brooders are used, the ventilation rates for birds older than 2 weeks should be increased by about 7% and the supplemental heat requirements should be increased by about 15% to compensate for the additional moisture added by the brooders.

TABLE A3 - Floor Housing for Breeding Flocks

	Floor System		
	Deep Litter Floor Dropping pits Under Roosts	Combination 1/2 - 2/3 Wire Or Slat Floor 1/2 - 1/3 Deep-Litter Floor	Complete Wire or Slat Floor
Floor Area per Hen:			
egg-strain breeds	2 sq ft[2]	1.0 sq ft	0.5 sq ft (min)
heavy breeds (over 2.27 kg)	3 sq ft[2]	1.5 sq ft[2]	1.0 sq ft[2] (min)
Feeding Space per 100 Hens:	If hand fed 20 ft of double-sided troughs or 4 round hanging feeders (pan diameter 16 in.). For automatic feeding reduce feeding space 50 percent.		
Watering Space per 100 Hens:	2 watering cups, 2 five gallon fountains or 60 linear in. of drinking troughs.		
Nesting Space per 100 Hens:	20 nests 10 in. by 12 in. by 13 in. high for both light and heavy breeds or 2 community nests 2 ft. by 4 ft.		

TABLE A4 - Ventilation and Heating Requirements for Breeder Flocks[1]

	Ventilation Rate (cfm per bird)			Supplemental Heat (BTUh/bird)			
Type of Bird	Winter	Spring/Fall	Summer	-35°F	-30°F	-25°F	-20°F
REPLACEMENT PULLETS							
Full Room				23.2	22.5	21.8	21.2
Brooding	Infiltration[2]	0.05	0.1				
Half Room				16.4	15.7	14.7	14.0
2 Weeks	0.05	0.15	1.0	12.6	11.9	12.3	10.2
8 - 20 Weeks	0.4	1.5	5.0	46.8	44.4	41.0	38.1
LAYING HENS							
Light Breeds							
- on litter				46.8	44.4	41.0	38.2
- on partial slats	0.4	1.4	6.0	36.9	34.8	31.7	29.7
- on slats				31.7	30.0	27.6	25.6
Heavy Breeds							
- on litter				67.3	63.8	59.1	55.3
- on partial slats	0.6	2.0	7.5	52.2	49.5	45.4	42.3
- on slats				47.5	44.7	41.0	38.2

1. Ventilation and heating requirements are calculated on the basis of maintaining barn temperatures and relative humidities of 95°F and 70% RH for brooding, 84°F and 80% at 2 weeks of age 60°F and 80% RH for the other groups of birds. Barn construction is R20 insulation in the walls and ceiling, with R8 perimeter foundation insulation. These rates are also based on maintaining the litter inside the barn at 45% moisture content.
2. Infiltration rate of air is taken as less than one-third air change per hour.

TABLE A5a - Floor, Feed & Water Space Requirements for Laying Flocks

- FLOOR HOUSING (SMALL COMMERCIAL OR HOBBY) FOR BROODING AND REPLACEMENT PULLETS

Age & Type of Bird	Floor Space (per bird)	Feeding Space (per bird)	Watering Space (per 100 birds)
0 - 2 weeks	0.5 ft^2	1 in.	2 - 4L fountains
2 - 8 weeks	0.7 ft^2	2 in.	60 in. (trough) 40 in. (fountains)
8 - 20 weeks	1.5 ft^2 (light breeds) 2.0 ft^2 (heavy breeds)	3 in.	60 in. (trough) 40 in. (fountains)

TABLE A5b - Floor Housing for Laying Flocks

	Floor System		
	Deep Litter Floor Dropping, pits Under Roosts	Combination ½ - 2/3 Wire Or Slat Floor ½ - 1/3 Deep-Litter Floor	Complete Wire or Slat Floor
Floor Area per Hen:			
egg-strain breeds	2 sq ft^2	1.0 sq ft^2	0.5 sq ft^2 (min)
heavy breeds (over 2.27 kg)	3 sq ft^2	1.5 sq ft^2	1.0 sq ft^2 (min)
Feeding Space per 100 Hens:	If hand fed 20 ft of double-sided troughs or 4 round hanging feeders (pan diameter 16 in.). For automatic feeding reduce feeding space 50 percent.		
Watering Space per 100 Hens:	2 watering cups, 2 five gallon fountains or 60 linear in. of drinking troughs.		
Nesting Space per 100 Hens:	20 nests, 10 in. by 12 in. by 13 in. high for both light and heavy breeds or 2 community nests 2 ft by 4 ft.		

TABLE A5c - Cage Housing

	Cage Space (per bird)	Feed Space (per bird)	Water Space (per cage)
Brooding & Replacement Pullets			
0 - 6 weeks	25 $in.^2$	1 in.	15 birds per nipple 25 birds per cup
6 - 18 weeks	45 $in.^2$	2 in.	8 birds per nipple 12 birds per cup
18 + weeks	60 $in.^2$	2 in.	8 birds per nipple 12 birds per cup
Laying Flock			
1.6 kg bird	64 $in.^2$	4 in.	1 water cup per cage or 1 per 2 cages
2.0 kg bird	72 $in.^2$	4 in.	depending on cage design

TABLE A6 - Ventilation and Heating Requirements for Laying Flocks[1]

	Ventilation Rate (cfm per bird)			Supplemental Heat (BTUh/bird)			
Type of Bird	Winter	Spring/Fall	Summer	-35°F	-30°F	-25°F	-20°F
REPLACEMENT PULLETS							
Full Room				23.2	22.5	21.8	21.2
Brooding	Infiltration[2]	0.05	0.1				
Half Room				16.4	15.7	14.7	14.0
2 Weeks	0.05	0.15	1.0	12.6	11.9	12.3	10.2
8 - 20 Weeks	0.4	1.5	5.0	46.8	44.4	41.0	38.1
CAGED REARED[3]							
Brooding	Infiltration	0.05	0.1	16.4	15.7	14.7	14.0
2 Weeks	0.05	0.15	1.0	12.6	11.9	12.3	10.2
8 - 20 weeks	0.2	1.5	5.0	16.4	14.7	13.0	12.3
LAYING HENS							
Floor Laying	0.4	1.5	6.0	46.8	44.4	41.0	38.2
Cages (deep pit)	0.5	2.0	7.0	31.7	30.0	27.6	25.6
Cages (shallow pits)[3]	0.3	2.0	7.0	18.1	16.7	14.7	13.0

1. Ventilation and heating requirements are calculated on the basis of maintaining barn temperatures and relative humidities of 95°F and 70% RH for brooding, 84°F and 80% at 2 weeks of age and 60°F and 80% RH for the other groups of birds. Barn construction is R20 insulation in the walls and ceiling with R8 perimeter foundation insulation. These rates are also based on maintaining the litter inside the barn at 45% moisture content if manure is stored for more than one week.
2. Infiltration rate of air is taken as less than one-third air change per hour.
3. Manure is removed from the barn every week. No attempt is made to dry the litter inside the barn.

TABLE A7 - Sizes for Egg Cooling Rooms

	1.67 Cases/100 Hens/Week			
Flock	3000-3600	3600-4200	4200-6000	6000-9600
Inside Size (Min.)	8′ x 8′	9′ x 10′	9′ x 12′	10′ x 14′
Cases (30 Doz.)	60	70	100	160
Refrigeration	4500 BTU	5100 BTU	6900 BTU	9900 BTU

(1 H.P. refrigeration approx. = 9000 to 12,000 BTU/h)

TABLE A8 - Floor, Feed and Water Space Requirements - Turkeys

Type of Bird	Floor Space (per bird)	Feeding Space (per bird)	Watering Space (per bird)
Broilers			
Hatching to 8 wk	1.0 ft^2	2″	5″ (or 35 poults/gal fountain)
8 wk to 14 wk	1.5 ft^2	3″	1 to 1.5″ (or 2 to 4 automatic fountains/100 birds)
Heavies			
Hens (to 18 wk)	4 ft^2	3″	1.5″ (4 automatic fountains/ 100 birds)
Breeding Flocks			
Light breeds			
Hens (to 13 lb)	3 ft^2	3″	1.5″ (4 automatic
Toms (to 20 lb)	5 ft^2	3″	1.5″ fountains/100 birds)
Heavy breeds			
Hens (to 17 lb)	4 ft^2	3″	1.5″ (4 automatic
Toms (to 28 lb)	6 ft^2	3″	1.5″ fountains/100 birds)
Nest space	1 nest per 5 hens, each 14″ x 24″ x 24″		
Broody space[1]	0.5 ft^2 of wire floor, no bedding, well lighted		
Range space	- 1000 birds per acre; moved each week - range shelters - 1.4 ft^2 for small breeds - 1.8 ft^2 for large breeds		

1. Area separate from breeding pen used to isolate "broody" breeder hens and restore egg production.

TABLE A9 - Ventilation and Heating Requirements for Turkey Flocks[1]

Type of Bird	Ventilation Rate (cfm per bird) Winter	Spring/Fall	Summer	Supplemental Heat (BTU/h/bird) -35°F	-30°F	-25°F	-20°F
Broilers (or replacements)							
Brooding	Infiltration[2]	0.06	0.25	35	34	33	32
2 weeks	0.06	0.14	0.60	30	29	28	27
8 weeks	0.24	1.00	5.60	30	29	26	25
14 weeks	0.72	2.60	14.00	80	74	69	65
Heavies							
18 weeks (17 lb)	1.0	4.0	20.0	140	133	124	118
22 weeks (20 lb)	2.0	6.0	32.0	228	217	203	194
Breeder flocks							
Light breeds							
Hens (to 13 lb)	1.0	3.0	16.0	104	99	92	87
Toms (to 20 lb)	1.4	5.0	25.0	167	160	150	140
Heavy breeds							
Hens (to 17 lb)	1.2	4.0	20.0	140	133	124	118
Toms (to 28 lb)	2.0	6.0	30.0	228	218	203	192

1. Ventilation and heating requirements are calculated on the basis of maintaining barn temperature at 95°F and 70% RH for brooding, 84°F and 80% RH at 2 weeks of age, 70°F and 80% RH at 8 weeks of age and 60°F and 80% RH for all other categories of birds. Barn construction is R20 insulation in walls and ceiling with R8 perimeter foundation insulation. These rates are also based on maintaining the litter inside the barn at 45% moisture content.

2. Infiltration rate of air is taken as less than one-third air change per hour.

CONVERSION FACTORS FOR METRIC SYSTEM

Imperial units	Approximate conversion factor	Results in:	
LINEAR			
inch	x 25	millimetre	(mm)
foot	x 30	centimetre	(cm)
yard	x 0.9	metre	(m)
mile	x 1.6	kilometre	(km)
AREA			
square inch	x 6.5	square centimetre	(cm^2)
square foot	x 0.09	square metre	(m^2)
acre	x 0.40	hectare	(ha)
VOLUME			
cubic inch	x 16	cubic centimetre	(cm^3)
cubic foot	x 28	cubic decimetre	(dm^3)
cubic yard	x 0.8	cubic metre	(m^3)
fluid ounce	x 28	millilitre	(mL)
pint	x 0.57	litre	(L)
quart	x 1.1	litre	(L)
gallon	x 4.5	litre	(L)
WEIGHT			
ounce	x 28	gram	(g)
pound	x 0.45	kilogram	(kg)
short ton (2000 lb)	x 0.9	tonne	(t)
TEMPERATURE			
degrees Fahrenheit	(^{o}F – 32) x 0.56 or (^{o}F – 32) x 5/9	degrees Celsius	(^{o}C)
PRESSURE			
pounds per square inch	x 6.9	kilopascal	(kPa)
POWER			
horsepower	x 746	watt	(W)
	x 0.75	kilowatt	(kW)
SPEED			
feet per second	x 0.30	metres per second	(m/s)
miles per hour	x 1.6	kilometres per hour	(km/h)
AGRICULTURE			
gallons per acre	x 11.23	litres per hectare	(L/ha)
quarts per acre	x 2.8	litres per hectare	(L/ha)
pints per acre	x 1.4	litres per hectare	(L/ha)
fluid ounces per acre	x 70	millilitres per hectare	(mL/ha)
tons per acre	x 2.24	tonnes per hectare	(t/ha)
pounds per acre	x 1.12	kilograms per hectare	(kg/ha)
ounces per acre	x 70	grams per hectare	(g/ha)
plants per acre	x 2.47	plants per hectare	(plants/ha)