# FARM BUILDING STANDARDS

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# FOREWORD

*Farm Building Standards, Canada, 1964* has been developed as a guide for those interested in the design, construction, and evaluation of a wide variety of farm buildings excluding the farm dwelling. It provides detailed recommendations to serve as references with the intent of obtaining safe and efficient performance and economy within such buildings. It is recognized that there are variations of good practice which may be equally satisfactory as those included and should be permitted if properly evaluated. This document is published as a supplement to the *National Building Code of Canada, 1960*, and is not intended to be mandatory.

For the most part, the requirements specifically refer to structural sufficiency, fire prevention, and health and sanitation and are recommended minimums necessary not only for the protection of people, but also to minimize loss of livestock and stored produce.

Individual designers may go beyond any of the recommendations included in the development of functional and efficient buildings as required for the multi-purpose requirement of the farm buildings.

The Supplement covers four main areas—

1. **Use and Occupancy** which relates to the function of farm buildings with regard to fire hazards, safety and dimensional requirements.

2. **Design** which deals primarily with specifications related to design and construction of new farm buildings and to the alteration of existing farm buildings.

3. **Building Services** which outlines the necessary services to control temperature and humidity, the electrical requirements for light and other services and the requirements for water supply and waste disposal.

4. **Health and Sanitation** which deals with building requirements necessary for the maintenance of conditions conducive to the good health of animals and suitable for the sanitary production of agricultural products.

The work of preparing the standards has been carried out through the Farm Building Standards Committee of the Associate Committee of the National Building Code. The Committee consists of engineers and specialists from universities and government, and related industry and services. It is intended that the Standards represent contemporary building practices in Canada.

# Acknowledgements

Permission to use material from the following documents has been kindly granted to the Associate Committee and is gratefully acknowledged:—

*Agricultural Engineering Year Book 1963* (American Society of Agricultural Engineers).

*Grain Storage Loads*, "Farm Construction Standards Committee Paper" (American Society of Agricultural Engineers).

*Journal*, September 1959 and September 1960 (American Society of Agricultural Engineers).

*Proceedings of Michigan Silo Conference 1961*, J. S. Boyd (Michigan State University).

*Transactions, 1959* (American Society of Agricultural Engineers).

### Other References

The Associate Committee wishes to acknowledge gratefully the assistance that has been obtained by the Farm Building Standards Committee from the following publications; if any information has thus been used for which prior formal permission should have been obtained, this has only been done unwittingly in the common task of assisting with the improvement of farm buildings, and regret is here recorded for any such slip.

*An Act Respecting Food and Drugs*, "Revised Statutes of Newfoundland, 1952", Chapter 56 (Dept. of Public Health, Province of Newfoundland).

*Commercial Storage of Fruits, Vegetables, Florists and Nursery Stock*, "Agricultural Handbook 66" (U.S. Department of Agriculture).

*Farm Service Buildings*, H. E. Gray (McGraw-Hill).

*Farm Structures*, H. J. Barre and L. L. Sammet (John Wiley and Sons).

*Henderson Report to National Institute of Health* (U.S. Public Health Service).

*Manitoba Dairy Act*, "Chapter 58, Statutes of Manitoba 1954" and "Manitoba Regulation 1558" (Dept. of Public Health and Welfare, Province of Manitoba).

*Minimum Requirements for Construction of Equipment and Maintenance of Milk Plants and Receiving Stations* (Dept. of Health and Public Welfare, Province of Manitoba).

*Regulations Governing the Construction, Maintenance and Operation of Class D Stock Yards* "Livestock Disease Act, Alberta Regulation 57-59" (Dept. of Public Health, Province of Alberta).

*Regulations for Milk Production, Milk Pasteurization Plants and Milk Plants* (Dept. of Public Health, Province of Nova Scotia).

*Regulations Governing Milk and Certain Milk Products, 1959* (Dept. of Public Health, Province of Saskatchewan).

*Regulations Governing the Production, Manufacture, Grading and Composition of Dairy Products under the Dairyman's Act* "Chapter 74, RSA 1955, Alberta Regulation 567-57" (Dept. of Public Health, Province of Alberta).

*Regulations re Grading and Inspecting of Honey Under the Vegetable and Honey Sales Act 1947* (Dept. of Public Health, Province of Saskatchewan).

*Regulations under the Milk Industry Act* "B.C. Regulation 32-58 and 102-58, October 23, 1958" (Dept. of Public Health, Province of Saskatchewan).

*Regulations under the Milk Industry Act* (Dept. of Public Health, Province of Ontario).

*Short Term Storage of Horticultural Crops*, J. L. Truscott (Horticultural Products Laboratory, Vineland Station, Ont.).

*The Public Health Act Standard Milk Regulations, 1960* (Dept. of Public Health, Prince Edward Island).

Papers prepared by the Canadian Institute of Timber Construction.

Papers prepared by the Portland Cement Association.

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# PART I USE AND OCCUPANCY

This Part relates to the function of farm buildings with regard to hazards and safety, and dimensional requirements.

## 1.1 HAZARDS AND SAFETY IN FARM BUILDINGS

This Section applies to the control of hazards in farm buildings for the purpose of minimizing losses of life and property.

### 1.1.1 Fire

#### 1.1.1.1 Classification of Building Occupancies by Fire Hazards—

(1) *Division I Buildings—High Hazard*

This group includes buildings occupied by flammable, highly combustible or explosive materials, and which due to the quantities of material or inherent characteristics of the occupancy, constitute a special fire hazard such as

(a) Liquid or gaseous fuel storage.

(b) Hay and bedding storage, tobacco curing and stripping, mechanical crop drying (excluding small grains), livestock feed grinding and preparation, furnace and boiler rooms.

(c) Animal and poultry brooding (where supplementary heating equipment creates an additional fire hazard).

(2) *Division II Buildings—Moderate Hazard*

This group includes buildings occupied by materials which are naturally less hazardous and/or which would burn with less intense heat than those of Division I, if ignited, such as

Small grain drying and storage

Animal and plant production (without supplemental heat)

Silage storage

Fruit and vegetable preparation and storage

Baled tobacco storage

Milk storage and handling

Equipment and vehicle storage and maintenance

#### 1.1.1.2 Measures Designed to Prevent the Spread of Fire within a Compartment—

*"Compartment", in this Section, means a building or part of a building that is required by these standards to be separated from another building or part of a building by a fire separation. A compartment may consist of one or several rooms or storeys.*

(1) *Fire-Stopping*

(a) All concealed spaces in wood framing and all furred spaces in masonry construction should be fire-stopped with wood blocking not less than 2 in. thick (nominal) or noncombustible material accurately fitted and arranged to prevent the spread of fire from one space to another.

(b) Fire-stops should be located at floor, ceiling and roof levels to cut off all concealed vertical draught openings so that

**1.1.1.2** (1) (b)

the maximum dimension of any concealed space is not greater than 10 ft.

(c) A clearance of at least 2 in. should be provided between masonry or concrete chimneys and combustible framing. This dimension may be reduced to ½ in. for exterior chimneys. All spaces between masonry or concrete chimneys and combustible framing should be sealed at top or bottom with noncombustible material.

(d) Openings around exposed pipes or power shafting should be filled with noncombustible material, or closed off by close-fitting metal caps at the ceiling and floor line and on each side of a wall or partition.

**1.1.1.3 Measures Designed to Retard the Spread of Fire Between Abutting Compartments or Between Buildings Separated by Less Than 20 Feet of Open Space—**

*"Fire endurance rating," in this Section, means the rating assigned to any element or assembly of materials which has been tested according to the method prescribed in ASTM Standard "Fire Tests of Building Construction and Materials" E119-61, published by the American Society of Testing and Materials, or British Standard "Fire Tests on Building Materials and Structures," BS 476, published by the British Standards Institution. Fire endurance ratings can be found in NBC Supplement No. 2 "Fire Resistance Ratings 1961" and NBC Supplement No. 5 "Housing Standards, Canada, 1963".*
*"Fire separation," in this Section, means a barrier against the spread of fire in the form of construction having a fire endurance rating, and in which openings are protected by closures having a fire endurance rating at least equal to the balance of the fire separation.*

(1) *Three-Quarter-Hour Fire Separation*

Three-quarter-hour fire separation should be provided

(a) to separate a compartment of Division I occupancy from all other occupancies,

(b) to subdivide buildings of Division I(b) into compartments not exceeding 5,000 sq. ft. total floor area, on one or more storeys, and

(c) to subdivide buildings of Division I(c) or Division II occupancies into compartments not exceeding 10,000 sq. ft. total floor area, on one or more storeys. (This paragraph does not apply to open-front livestock buildings containing no stored hay or bedding.)

(2) *Division I(a) Occupancies (Fuel Storage)*

These occupancies should be separated from all other occupancies by at least 60 ft. of open space unless local authorities permit or require some other separation.

(3) *Two-Storey Barns*

A special hazard to livestock and humans exists where large

amount of hay and bedding could burn in the second storey over housed livestock such as cattle or horses. The mow floor and all closures should provide reasonable fire protection. No fire endurance ratings are available for a situation with fire above the floor.

(4) *Fire Separation*

(a) Every fire separation should be so designed, constructed and supported that it can be expected to remain intact and in position during the period of time that it is required to perform.

(b) Every fire separation should be supported to the ground by construction having fire resistance at least equal to the supported separation.

(c) Combustible construction which abuts or is supported by a fire separation shall be constructed in such a manner that its collapse under fire conditions will not cause the collapse of the fire separation.

(d) Every wood joist should be fire-cut when it rests in a pocket in a noncombustible fire separation wall.
*"Fire-cut," when applied to wood joists and beams, means that the ends are cut at an angle such that the top of each joist or beam does not penetrate appreciably into the supporting masonry wall, thereby permitting the joist or beam to fall freely without rupturing or overturning the wall.*

(e) Where a noncombustible fire separation terminates on the exterior wall or roof surface, no combustible material other than sheathing and cladding should extend across the end of the fire separation to form a bridge where fire could cross. The space between the fire separation and the cladding should be tightly sealed by caulking with mineral wool or similar noncombustible material.

(f) No combustible member of any kind should pierce a fire separation in such a way that it reduces its fire endurance rating to less than ¾ hr.

(g) Where pipes or ducts which are not enclosed in shafts pass through a fire separation they should be tightly fitted or fire-stopped to prevent the passage of smoke and flame from one separated area to another.

(h) Fire Resistive Closures:

(i) Fire resistive closures should be tested by a recognized laboratory in accordance with ASTM Standard "Fire Tests of Door Assemblies", E152-58, published by the American Society of Testing and Materials.

(ii) Doors in interior fire separations should have counterweights or other self-closing devices and should be kept closed during normal occupancy.

(i) A duct that passes through a fire separation should be equipped with an automatic damper that operates at a tempera-

**1.1.1.3** (4) (i)

ture approximately 50° F above the maximum temperature that will normally be encountered in the system and that is equipped with spring catches, pins or hinges of corrosion-resistant material.

**1.1.1.4 Factors Affecting the Fire-Spread Between Buildings—**

(1) The probability of the spread of fire from building to building is affected by a number of factors. Table I indicates recommended minimum distances between buildings to prevent the spread of fire under average farm conditions.

**TABLE I**

**Recommended Minimum Distances Between Buildings to Prevent the Spread of Fire Due to Radiation**

| Occupancy Classification of Burning Building | Dimensions of Burning Building Seen by Adjacent Building Height to Ridge (ft.) x Length (ft.) | Recommended Space Separations for Ordinary Constructions with Windows (ft.) |
|---|---|---|
| Division I | 10 x 14 | 40 |
| | 10 x 50 | 70 |
| | 10 x 100 | 95 |
| | 12 x 20 | 50 |
| | 20 x 30 | 80 |
| | 20 x 50 | 100 |
| | 30 x 60 | 135 |
| Division II | 10 x 14 | 30 |
| | 10 x 50 | 55 |
| | 10 x 100 | 75 |
| | 12 x 20 | 45 |
| | 20 x 30 | 65 |
| | 20 x 50 | 80 |
| | 30 x 60 | 105 |

(2) Where it is not practical to provide the recommended separations, reasonable reductions in separations may be made at the discretion of the designer and owner on the basis of any one of the following considerations

(a) Availability of adequate fire-fighting facilities, so located and provided with water source that they can be put into service in time to protect exposed buildings.

(b) Availability of an adequate fire alarm system.

(c) Characteristics of the potential burning building

(i) Probability of ignition related to the occupancy.

(ii) Absence of openings in the exterior walls through which a fire in the contents of the building could expose an adjacent building.

**1.1.1.4** (2) (c)

(iii) Design and construction of the building structure and exterior walls so that they will remain intact and contain the fire during its peak intensity, thus reducing the intensity of exposure of adjacent buildings.

(iv) Low potential fuel contribution from the building and its contents related to the occupancy.

(d) Characteristics of the potential exposed building

(i) The absence of openings in the exposed walls through which ignition of contents could occur through radiation and/or the entry of flying embers.

(ii) Reduced combustibility of exterior walls, trim, and roofing combined with wall and roof construction which would prevent the escape of combustible gases.

(iii) Reduced thermal conductivity of exterior walls where combustible contents may be located adjacent to the walls or where spontaneous combustion of the contents could be triggered by the absorption of heat from a burning building.

(3) Where a combination of the conditions in sentence (2) (a) (b) (c) and (d) exist in such a way that they are mutually complementary, substantial reductions of the distances shown in Table I may be justified. Where this allows buildings to be located at spacings of 20 ft. or less, fire separation should be provided in accordance with clause 1.1.1.3.

(4) The spatial separations contained in Table I do not provide protection against wind-carried embers, because of their possible widespread distribution. For this reason, consideration should be given to the combustibility of farm building roofs and the presence of openings in walls regardless of the building location.

**1.1.1.5 Requirements for Exits—**

*"Exit (for people only)", in this Section, means a safe way of escape from the floor area to open space. An exit for this purpose may consist of a regularly used stairway or doorway. Alternatively, if the exit is provided for emergency use only, it may be an easily-opened door, window, or panel, measuring at least 22 in. by 36 in. The bottom of the opening should be not less than 24 in. and not more than 36 in. above floor level. If the bottom of the wall opening is more than 8 ft. above grade, a permanent outside ladder should be attached.*

*"Exit (for horses and cattle)", in this Section, means an opening from the floor area to open space; such opening may be a single door 3 ft. to 3 ft. 6 in. or a double doorway 5 ft. minimum width dimensions. Where the total change in floor elevation exceeds 10 in., a ramp or steps should be provided. Ramps or steps should meet the requirements shown in clauses 1.2.1.1(5)(g) or 1.2.1.1(5)(h).*

(1) Every floor area should be served by exits to the extent that the travel distance to the nearest exit should not exceed

(a) 75 ft. in any occupancy in Division I (see clause 1.1.1.1(1)),

**1.1.1.5** (1)

(b) 100 ft. in any other occupancy, except in occupancies for horses and cattle which should be 50 ft.

(2) At least 2 exits, as widely separated as possible, should be provided for areas exceeding 200 sq. ft., except in buildings such as silos, grain bins, controlled atmosphere storage, tobacco kilns and milkhouses.

### 1.1.2 Lightning

(1) Lightning Rod Acts should be consulted to determine materials and apparatus to be used in protecting buildings against lightning.

(2) Wire fences should have metal posts at intervals of 150 ft.

### 1.1.3 Suffocation

(1) Sealed rooms such as walk-in coolers and controlled atmosphere storages should be equipped with door latches that open from inside the room and with warning lights to show when the room is occupied.

(2) Maintenance shops and other enclosed spaces where internal combustion engines may be operated should be equipped with exhaust systems which are independent of the building heating and ventilation systems.

### 1.1.4 Safety

#### 1.1.4.1 Guard Rails—

(1) Where ramps, platforms, hay chutes, landings, etc., are more than 2 ft. above adjacent floor or grade levels, guard rails should be provided.

(2) The top of guard rails should be not less than 36 in. and not more than 42 in. above floor level.

(3) For traffic areas likely to be occupied by humans only, guard rails should be capable of safely resisting a horizontal force of 100 lb. at any point.

(4) Guard rails for livestock should be designed for the intended use.

#### 1.1.4.2 Stairways—

(1) Exit doors that open outward should not open directly on a flight of stairs but should open on a landing, the minimum dimension of which should be at least equal to the door width.

(2) Every flight of stairs should have a minimum of 2 risers.

(3) Ramps should be provided where the total change in elevation is less than 10 in.

(4) Stairs for human traffic should have 9 in. maximum rise, 8 in. minimum run and 9 in. minimum tread.

(5) In any flight of stairs, the rise, run and tread should be uniform.

(6) Rectangular landings should be provided when stairs change direction.

**1.1.4.3 Ladders**—

(1) If stairways are not feasible, permanently installed ladders should be provided when frequent access is required to locations more than 10 ft. above floor or ground level.

(2) Permanent ladders should terminate 5 ft. above ground for child safety.

(3) All roof ladders should be permanent.

(4) Ladders should extend 3 ft. above the upper landing, or other hand-holds should be provided.

(5) A clear space not less than 5½ in. should be provided behind all rungs, steps or cleats.

(6) The spacing of rungs, steps or cleats of any ladder should be uniform and should not exceed 12 in.

**1.1.4.4 Covers for Cisterns, Wells and Septic Tanks**—

(1) Covers of rot- and corrosion-resistant material should be provided for cisterns, wells and septic tanks.

(2) Manhole covers or portions thereof should weigh at least 40 lb.

**1.1.4.5 Bull Pens**—Bull pens should be provided with safety areas and a protected means of egress.

## 1.2 SPACE REQUIREMENTS OF FARM BUILDINGS

This Section states the requirements for space and facilities for the animals and the products and services associated with the production.

### 1.2.1 Animal Production

**1.2.1.1 Dairy Cattle**—

(1) *General*

(a) Where the dairy operator raises his own replacement stock, the total number of animals to be housed will be normally twice the number of milking cows.

(b) Using the milking herd as a basis, the number of animals to be housed may be estimated as follows

dry cows.....12 per cent

heifers.....50 per cent

calves (under 6 weeks).....12 per cent

calves (6 weeks to 10 months)....25 per cent

(2) *Tie Stall Barns*

(a) The floor to ceiling height should be a minimum clear distance of 7 ft. 6 in.

(b) The litter alley should be a minimum of 8 ft. wide between gutters and 6 ft. wide between gutter and wall.

(c) Feed alleys for hand feeding should be a minimum of 3 ft. 6 in. wide.

(d) Cross alleys should be a minimum of 4 ft. wide.

(e) Mangers for milk cows should be not less than 20 in. or more than 24 in. wide when of the sweep-in type and a minimum of 28 in. wide when of the high-front type.

(f) Gutter dimensions should be as given in clause 4.1.1.1, (2)(b)(iii).

(g) The dimensions for stalls should be as given in Table II.

**TABLE II**

**Dimensions for Tie-Stalls for Dairy Cows**

| Wt. of Cow lb. | Girth in. | Stall Width* | Stall Length** |
|---|---|---|---|
| 800 | 65 | 3 ft. 4 in. | 4 ft. 6 in. |
| 1000 | 70½ | 3 ft. 8 in. | 4 ft. 8 in. |
| 1200 | 75 | 4 ft. 0 in. | 5 ft. 0 in. |
| 1400 | 79½ | 4 ft. 4 in. | 5 ft. 4 in. |
| 1600 | 84 | 4 ft. 8 in. | 5 ft. 8 in. |

* Increase width by 4 in. for comfort stalls.
** Increase length by 6 in. for tie stalls, 4 to 6 in. for electric cow trainer or comfort stalls.

(3) *Loose Housing*

(a) Floor resting areas should provide 60 sq. ft. per head for milking cows and 40 sq. ft. per head for dry cows and heifers, and have a minimum clear height of 10 ft.

(b) Free stalls should be a minimum of 7 ft. 6 in. long, 3 ft. 9 in. wide and 8 ft. in height and the litter alley should be at least 8 ft. wide between stall curbs. For small breeds, an adjustable brisket board at the head of the stall should be installed.

(c) The exercise yard should provide

(i) if hard surfaced—a min of 60 sq ft. per head for dry cows and heifers, and

(ii) if unpaved—300 sq. ft. per head for milking cows and 200 sq. ft. per head for dry cows and heifers Unpaved exercise yards are not recommended in areas where annual precipitation is more than 20 in.

(d) The feed bunk should allow

(i) if self fed—1 ft. per head for milking cows and 8 in. per head for dry cows and heifers, and

(ii) if fed at time intervals—2 ft. 8 in. per head for milking cows and 2 ft. 6 in. for dry cows and heifers.

(iii) minimum width of 24 in. if animals fed from one side, and 36 in. if fed from both sides.

(e) The feeding area not including manger, should be at least 12 ft. wide for milking cows and 10 ft. wide for dry cows and

heifers. In the case of parallel mangers, 18 ft. between mangers for milking cows and 16 for dry cows and heifers should be provided.

(f) Watering surface should be provided at the rate of 1 sq. ft. for each 25 head of cows and heifers.

(g) The water and feeding facilities should not be located in the resting area.

(4) *Pens*

(a) One maternity pen having minimum dimensions of 10 ft. x 10 ft. should be provided for every 20 cows.

(b) Individual pens for calves under 6 weeks of age should provide 15 sq. ft. per head and group pens for calves 6 weeks to 10 months should provide 24 sq. ft. per head.

(5) *Milking Parlors*

(a) The operator alley should be a minimum of 4 ft. wide.

(b) Stalls should be at least 2 ft. 9 in. wide except for the herringbone type which should be 6 ft. wide.

(c) The cow alley should be at least 3 ft. wide with an increase to 4 ft. at turns.

(d) The stall length should be as follows

8 ft. for side entering

8 ft. 6 in. for walk through

4 ft., plus 2 ft. 9 in. per stall for herringbone.

(e) The ceiling height should be a minimum of 7 ft. clear distance above stall floor.

(f) The cow platform height should be a minimum of 2 ft. 6 in. above operator floor area.

(g) The ramp slope to the cow platform should not be more than 4 in. per ft. and should be provided with a roughened, cleated or grooved surface.

(h) The rise of steps should be not more than 9 in. and the run should be 24 in.

(6) *Milkhouses or Milkrooms*

See clause 4.1.1.1,(3)(a) to (e) and (g).

(7) *Storage*

(a) Storage space for feed should be provided depending on management practices. For design purposes the following quantities for the milking herd may be used

(i) 30 lb. per cow day of hay if no silage is fed

(ii) 90 lb. per cow day of silage if no hay is fed

(iii) 6 to 9 lb. per cow day of grain and concentrate.

**1.2.1.1** (7) (a)

**NOTE**

See Appendix A, Table A-II for weights of various agricultural materials.

(b) Approximately 50 per cent additional storage should be provided for the rest of the herd.

(c) Storage for bedding should be provided depending on management practices and the usage rates listed in Table III.

**TABLE III**

**Bedding Requirements for Dairy Cattle**

| Cattle | Loose Housing lb./head/day | Free Stalls lb./head/day | Tie Stalls lb./head/day |
|---|---|---|---|
| Milking Cows | 15 | 4 | 8 |
| Dry Cows and Heifers | 8 | 2 | 4 |

**1.2.1.2 Beef Cattle**

(1) Requirements for the accommodation of beef cattle should be as shown in Table IV.

(2) Small calves housed on slotted floors should be given 10 sq. ft. per head in stalls and 20 sq. ft. in pens. The slat and slot widths should be 2 in. and ½ in. respectively.

1.2.1.2

TABLE IV

**Requirements for the Accommodation of Beef Cattle**

| Accommodation | Requirements | | |
|---|---|---|---|
| | Cows and 2-yr. olds | Yearlings | 500-lb. Calves |
| **Feed Lot (with shed)**— | | | |
| lot area | | | |
| —hard surfaced | 50 sq. ft. min. | 25 sq. ft. min. | 25 sq. ft. min. |
| —soil | 300 " " " | 250 " " " | 150 " " " |
| shed area | | | |
| —floor area | 30 sq. ft. min. | 20 sq. ft. min. | 15 sq. ft. min. |
| —clear height | 10 ft. min. | 10 ft. min. | 10 ft. min. |
| **Feed Lot (without shed**— | | | |
| hard surfaced | 80 sq. ft. | 45 sq. ft. | 40 sq. ft. |
| soil | 300 " " | 250 " " | 150 " " |
| **Slotted Floors**— | | | |
| space per animal | 30 sq. ft. | 20 sq. ft. | 12 sq. ft. |
| % slotted floor area | 100 | 100 | 100 |
| slot width | 1½ in. | 1½ in. | 1½ in. |
| slat width | 5 in. | 5 in. | 5 in. |
| **Maternity Pens** | 1 pen/20 cows 10 ft. x 10 ft. | | |
| **Feed Bunk**— | | | |
| length per head | | | |
| —group feeding | 2 ft. | 1 ft. 8 in. | 1 ft. 6 in. |
| —self feeding | 8 in. | 8 in. | 6 in. |
| height at throat | 2 ft. 6 in. | 2 ft. 0 in. | 2 ft. 0 in. |
| **Water**— | | | |
| surface area | 1 sq. ft. per 25 head | 1 sq. ft. per 25 head | 1 sq. ft. per 30 head |
| **Bedding Storage**— | | | |
| (except for slotted floors) | 8 lb./head/day | 6 lb./head/day | 4 lb./head/day |
| **Feed Storage**— | Feeding practices highly variable | | |

**1.2.1.3 Sheep**—The requirements for the accommodation of sheep should be as shown in Table V.

1.2.1.3

TABLE V

**Requirements for the Accommodation of Sheep**

| Accommodation | Requirements | |
|---|---|---|
| | **Ewes or Rams** | **Feeder Lambs** |
| **Feed Lot—** | | |
| hard surfaced | 15 sq.ft. per head | 6 sq. ft. per head |
| soil | 30 " " " " | 12 " " " " |
| **Open Front Shed—** | | |
| floor area | 15 sq. ft. per head | 6 sq. ft. per head |
| depth | 20 ft. in both directions | 20 ft. in both directions |
| ceiling height | 9 ft. | 9 ft. |
| **Slotted Floors—** | | |
| area per animal | 7 sq. ft. | 4 sq. ft. |
| % slotted floor area | 100 | 100 |
| slot width | ¾ in. | ¾ in. |
| slat width | 2 in. | 2 in. |
| **Lambing Pen—** | | |
| floor area | 16 sq. ft. | |
| **Feed Rack*—** | | |
| length per head | 16 in. group feeding<br>6 in. self-fed | 12 in. group feeding<br>4 in. self-fed |
| height at throat | 12 in. small breeds<br>15 in. large breed | 10 in. small breeds<br>12 in. large breeds |
| **Feed Storage**—** | | |
| hay | 600 lb./head/winter | 100 lb./head/winter |
| grain | 75 lb./head/winter | 125 lb./head/winter |
| **Bedding Storage**** | 150 lb./head/winter | 50 lb./head/winter |
| **Water—** | | |
| surface area | 1 sq. ft./40 head | 1 sq. ft./40 head |

* Some sheepmen prefer the five-sided feeders allowing 2 ft. on a side for 2 sheep.

** Feed and bedding requirements are based on 200 feeding days.

**1.2.1.4 Swine**—The requirements for the accommodation of swine should be as shown in Table VI.

**TABLE VI**

**Requirements for the Accommodation of Swine**

| Accommodation | Requirements | | |
|---|---|---|---|
| | **Sows** | **Pigs—under 50 lb.** | **Pigs—50 to 200 lb.** |
| **Feed Lot—** | | | |
| hard surfaced | 25 sq. ft. per sow | 8 sq. ft. per pig | 20 sq. ft. per pig |
| pasture | 1 acre per 2 sows with litters | 1 acre per 25 pigs | 1 acre per 10 pigs |
| **Building—** | | | |
| pen area | 25 sq. ft. per sow under 400 lb.<br>35 sq. ft. per sow over 400 lb.<br>64 sq. ft. per sow under 400 lb. with litter<br>80 sq. ft. per sow over 400 lb. with litter | 3 sq. ft. per pig | 8 sq. ft. per pig |
| pen partition height | 3 ft. | 2 ft. 8 in. | 2 ft. 8 in. |
| **Slotted Floors—** | | | |
| pen area per pig | | | 7 sq. ft. |
| —slotted floor area | | | 25-100 per cent |
| —slot width | | | ⅝ in.—1 in. |
| —slat width | | | 1½ in.—5 in. |
| **Self Feeder Length** | 6 in. per sow | 2 in. per pig | 3 in. per pig |
| **Feed Trough Length** | 1 ft. 6 in. per sow | 10 in. per pig | 1 ft. 1 in. per pig |
| **Individual Feeding** | 1 ft. 6 in. x 6 ft. 6 in. x 3 ft. 6 in. high | | 1 ft. 1 in. x 5 ft. x 2 ft. 6 in. high |
| **Farrowing Stalls—** | 5 ft. x 7 ft. (including 2 creeps) | | |
| clearance under creep partition | 9 in. | | |
| **Water** | 1 watering cup per 15 sows | 1 watering cup per 25 pigs | 1 watering cup per 20 pigs |
| **Feed** | 1 ton per year | 1000 lb. feed from birth to market | |
| **Bedding** | ½ ton of straw or equivalent | | |

**1.2.1.5 Horses**—The requirements for the accommodation of horses should be as shown in Table VII.

**TABLE VII**

**Requirements for the Accommodation of Horses**

| Accommodation | Requirements | | |
|---|---|---|---|
| | Two-Year Old or More | | Yearling |
| | Small Breeds | Large Breeds | |
| Stall Sizes— | | | |
| width | 5 ft. | 5 ft. | |
| length | 10 ft. including manger | 12 ft. including manger | |
| box stall | 10 ft. x 10 ft. | 12 ft. x 14 ft. | 8 ft. x 10 ft. |
| Hay Manger— | | | |
| width | 2 ft. 3 in. | 2 ft. 3 in. | 2 ft. |
| height at throat | 3 ft. 2 in. | 3 ft. 6 in. | 2 ft. 9 in. |
| Grain box | 1 ft. x 2 ft. | 1 ft. x 2 ft. | 1 ft. 6 in. x 10 in. |
| Feed Storage/yr.— | | | |
| hay | 2 tons | 2 tons | 1 ton |
| grain | 40 bushels | 80 bushels | 30 bushels |

**1.2.1.6 Chickens**

(1) The requirements for floor housing of laying hens should be as shown in Table VIII.

(2) The requirements for floor housing of breeding flocks are identical to those for the deep litter system in Table VIII except that the floor area should be increased to 3 sq. ft. and 4 sq. ft. for light and heavy breeds respectively.

TABLE VIII

**Requirements for Floor Housing of Laying Hens**

| Accommodation | Floor System | | |
|---|---|---|---|
| | **Deep Litter Floor, dropping pits, under roofs** | **Combination 2/3 Wire or Slat Floor, 1/3 Deep-Litter Floor** | **Complete Wire or Slat Floor** |
| **Floor Area, per hen—** | | | |
| light breeds (under 5 lb.) | 2 sq. ft. | 1.25 sq. ft. | 1.25 sq. ft. |
| dual-purpose and heavy breeds (over 5 lb.) | 3 sq. ft. | 2 sq. ft. | |
| **Roosting Space, per hen—** | | | |
| light breeds | | | |
| —space on roost | 7 in. | | |
| —roost spacing | 13 in. on centre | | |
| dual-purpose and heavy breeds | | | |
| —space on roost | 9 in. | | |
| —roost spacing | 15 in. on centre | | |
| **Feeding Space per 100 hens** | 20 ft. for hand-fed troughs, 10 ft. for automatic troughs, or 4 round hanging feeders (pan diameter, 16 in.) | | |
| **Watering Space per 100 hens** | 2 watering cups, 2 five gallon fountains or 4 ft. of drinking troughs. | | |
| **Nesting Space per 100 hens** | 20 nests, 10 x 12 x 14 in. high for both light and dual purpose breeds or one community nest 2 ft. by 8 ft. | | |

(3) Requirements for laying hens confined in cages depend on the size and type of cages used, and the number of birds in each cage. Cage housing is used for egg production but not for breeding purposes.

(a) Where carts are used for feeding and egg-gathering, a clear distance of 8 ft. from cages to end wall should be provided.

(b) A 30-in. minimum clear hallway width should be provided between rows of combined cages and at outside long walls.

(4) The requirements for the accommodation of broilers, roasters and replacement pullets should be as shown in Table IX. Broilers are normally marketed in 10 weeks and roasters in 16 weeks.

## TABLE IX

### Requirements for the Accommodation of Broilers, Roasters and Replacement Pullets

| Accommodation | Age (Weeks) | | | |
|---|---|---|---|---|
| | 0—2 | 3 | 7—10 | 11—20 |
| Floor area* per bird (sq. ft.) | 0.5 | 0.75 | 1.0 | 2.0 (light breeds)<br>2.5 (dual-purpose) |
| Length** of feed space per bird (in.) | 1 | 2 | 3 | 4 |
| Watering space per 100 birds | 2 fountains at 1 gal. each | automatic troughs, 4 ft. or 2 fountains at 3 gal. each | automatic troughs, 4 ft. or 2 fountains at 5 gal. each | 4 ft. of trough or 8 ft. of space |
| Other Requirements | Not over 350 birds per unit brooder | Roosts required, 0.25 ft. per bird (except broilers) | Roosts required at 0.45 ft. per bird (light breeds) and 0.5 ft. per bird (heavy breeds), (except broilers) | |

* Expanding floor area may be provided by removable plastic curtains or other suitable materials hung from the ceiling. Total building area should be based on the requirements at time birds are removed.

** Where feed troughs are used from both sides, 1 in. of trough equals 2 in. of feed space.

1.6

(5) The space requirements for the storage of feed for chickens should be based on the feed consumption listed in Tables X and XI.

TABLE X

**Feed Requirements for Raising Broilers, Roasters and Replacement Pullets**

| Age in Weeks | Cumulative Feed Requirements per 100 chickens (lb.) | |
|---|---|---|
| | Light Breeds | Heavy Breeds |
| 2 | 40 | 50 |
| 4 | 135 | 155 |
| 7 | 380 | 480 |
| 10 | 700 | 900 |
| 12 | 940 | 1170 |
| 16 | 1430 | 1775 |
| 20 | 1945 | 2400 |

TABLE XI

**Feed Consumption of Laying Hens**

| Type of Bird | Average Feed Consumption per 100 birds per day (lb.) |
|---|---|
| Light Breeds | 25 |
| Dual-Purpose | 27 |
| Heavy Breeds | 28 |

### 1.2.1.7 Turkeys

(1) The requirements for the accommodation of turkey breeding flocks should be as shown in Table XII.

TABLE XII

**Requirements for the Accommodation of Turkey Breeding Flocks**

| Accommodation | Requirements |
|---|---|
| Floor Area, per bird—<br>small breeds<br>large breeds | <br>6 sq. ft.<br>8 sq. ft. |
| Roost Space per bird—<br>small breeds<br>large breeds | <br>12 in. with roost 20 in. o.c.<br>16 in. with roost 24 in. o.c. |
| Feed Space—per bird | 4 in. |
| Watering Space—per bird | 1½ in. |
| Nest Space—per 3 hens | 1 nest—14 in. x 24 in. x 24 in. |
| Feed Consumption—<br>toms<br>hens | <br>1 lb. per day<br>0.55 lb. per day |

(2) The space requirements for brooding turkey poults should be as follows

(a) The floor area per bird should be increased from 1 sq. ft. at 2 weeks to 3 sq. ft. at 16 weeks.

(b) If turkeys are to be raised in confinement beyond the age of 16 weeks, a floor area of 5 sq. ft. per bird should be provided.

(c) The feed space per bird should be increased from 2 in. at 2 weeks to 4 in. at 16 weeks.

(d) The watering space per bird should be increased from ¾ in. at 2 weeks to 1½ in. at 16 weeks.

### 1.2.1.8 Fur-Bearing Animals—

(1) *Mink*

The space requirements for mink pens should be as follows

(a) The breeder pen for confinement of the bred female and her kits should be 18 in. wide x 18 in. high by 48 in. long which includes 12 in. for the wood nest box in addition to the length of the wire cage.

(b) The pelter pen for confinement of a mink raised for the pelt should be 30 in. long x 12 in. wide x 28 in. high which includes 10 in. of height for the wood nest box which is attached to the top of the wire cage.

(c) Mink pens arranged side-by-side in rows should be at least 3 in. apart.

**1.2.1.8** (1)

(d) Minimum clear hallway width between rows of mink pens should be 40 in.

(e) Pens should be elevated at least 24 in. from the ground to the bottom of wire cages.

(2) *Foxes*

Individual fox pens should be 4 ft. x 7 ft. x 3 ft. high with the pen bottom elevated 2 ft. above grade.

### 1.2.2 Plant Production

**1.2.2.1 Greenhouses**—Greenhouse area requirements for crops to be transplanted should be determined from Table XIII. The required area of greenhouse is affected by such factors as crop variety and weather at time of planting.

TABLE XIII

**Greenhouse Area Requirements per Acre of Transplanted Crop**

| Crop | Required Greenhouse Bed Area sq. ft. per acre of Transplanted Crop |
|---|---|
| Tobacco— | |
| flue-cured type and Burley type | 100 |
| Tomatoes— | |
| early | 65—85 |
| stake | 100—165 |
| late | 8—14 |
| Cabbage | 50—70 |
| Cauliflower | 30—50 |
| Celery | 85—100 |
| Cucumber | 110—150 |
| Eggplant | 90—120 |
| Lettuce | 60—70 |
| Muskmelon | 40—65 |
| Onions, Spanish | 47—53 |
| Pepper | 50—60 |
| Watermelon | 25—50 |

### 1.2.3 Product Storage

This subsection deals with the dimensions of buildings based on the requirements of the products to be stored (See Appendix A, Table A-II for unit weights of various agricultural materials)

**1.2.3.1 Corn Storage in Cribs—**

(1) For natural wind drying of cob corn in storage, the effective storage width at the base of the crib should not exceed 5 ft.

(2) The open area of slatted crib walls should be at least 30 per cent of the total wall.

1.2.3.1

(3) If openings are horizontal slots, the vertical dimension of the slots should not be over 1½ in.

(4) If openings are vertical slots, the horizontal dimension of the slots should not exceed 2 in.

**1.2.3.2 Silage—**

(1) *Horizontal Silos*

(a) For end self-feeding, the vertical dimension of the settled silage should be not over 6 ft. For mechanical unloading, the vertical dimension is limited only by the reach of the mechanical unloader.

(b) The feeding-face at floor elevation should be 4 to 5 in. wide per beef cow or steer and 6 to 8 in. wide per dairy cow provided that the cattle have access to the feeding face 24 hours a day.

(c) The minimum horizontal usage rate of silage in horizontal silos should be 3 in. per day in cool weather and 4 in. per day in warm weather.

(d) The length of horizontal silo should be based on the usage rate in (c), times the length of feeding period.

(e) The end area of horizontal silos should be determined by the daily feed requirement, the usage rate and the depth of silage.

(2) *Vertical Silos*

(a) Required vertical dimensions of settled silage, high-moisture shelled grain corn, cracked grain corn or ground ear corn in conventional vertical silos should be based on a minimum usage rate of 2 vertical inches per day in cool weather and 3 vertical inches per day in warm weather (See Appendix A, Table A-II for the volume weight of settled silage in horizontal and vertical silos.)

(b) The total wall height of a vertical silo should be determined from the required depth of settled silage plus 5 ft. to allow for settling if refilled once and plus an additional 5 ft. if a mechanical top-unloader is suspended in the silo at time of filling.

**1.2.3.3 Potato Storage—**

(1) Space requirements for potato storages should be based on 4 cu. ft. per barrel (165 lb.), 1.5 cu. ft. per bushel or 42 lb. per cu. ft. net storage area.

(2) Approximately 5 per cent should be added to compensate for space occupied by partitions in bulk storages.

(3) Approximately 20 per cent should be added to compensate for space occupied by containers in pallet box storages.

(4) The height of bulk stored potatoes should not exceed 14 ft.

(5) A minimum ceiling height should be the height of stored potatoes plus 1 ft. to provide for proper air circulation.

### 1.2.4 Processing

#### 1.2.4.1 Tobacco—

(1) *Flue-Cured Tobacco*

(a) Kilns:

(i) At least one standard kiln for hot-air curing is normally provided for every 7.5 marketable acres of flue-cured type tobacco.

(ii) The dimensions of a standard tobacco kiln are as listed in Table XIV.

(b) Pack Barns:

(i) Tobacco pack barns for storage of the cured tobacco should be single-stored, with a smooth, hard-surfaced noncombustible floor. The floor should have no abrupt elevation changes from pack barn to steam room to stripping room.

(ii) The pack barn should provide 72 sq. ft. of floor area per acre of tobacco and should be at least 36 ft. wide, and should have a vertical clearance of at least 11 ft.

**TABLE XIV**

**Dimensions of Tobacco Kilns**

| Measurements | Dimensions |
|---|---|
| **Outside Horizontal** | **22 ft. 6 in. wide x 24 ft. long** |
| Vertical— | |
| earth floor below grade | 1 ft. 4 in. |
| floor to top of concrete foundation | 6 ft. 0 in. |
| floor to bottom of first hanger | 7 ft. 6 in. |
| floor to top of plate | 18 ft. 9 in. |
| floor to top of roof ridge | 27 ft. 0 in. |
| Hanger Spacing, on centre— | |
| vertical spacing | 2 ft. 5 in. |
| horizontal spacing | 3 ft. 8 in. |

(iii) Outside doors should be provided at the centre of each end wall with a minimum opening 12 ft. by 11 ft.

(iv) One door with minimum opening 2 ft. 6 in. by 6 ft. 8 in. should be provided giving direct access from the pack barn to the stripping-room.

(v) If the pack barn has inside columns, the columns should be spaced to provide a clear area through the centre of the building in line with the large end door or doors.

(vi) Pack barns should have no windows or other openings which could admit natural light.

**1.2.4.1** (1)

(c) Steam-Rooms:

(i) A steam-room should be provided for adjusting the moisture content of cured tobacco prior to stripping.

(ii) The inside dimensions of the steam-room should be at least 9 ft. wide, 7 ft. 6 in. high, and 11 ft. long.

(iii) Two doors, each with clear opening 4 ft. 6 in. by 7 ft. 4 in., should be located in each end of the steam-room. The doors should be arranged to permit passage of tobacco stripping racks from pack-barn to steam-room to stripping-room.

(iv) Walls connecting the tobacco pack barn with the stripping-room should be steam tight.

(d) Stripping-Room:

(i) A stripping-room should be provided for stripping, grading, and baling tobacco.

(ii) The stripping-room should have floor dimensions of at least 14 ft. by 30 ft. and 52 lineal ft. of bench space, 40 in. deep, adjacent to outside walls.

(iii) If natural light is to be used for grading, windows should be continuous above the bench and have a north or east exposure.

(2) *Burley Tobacco*

(a) Curing Barns:

(i) The barn should be oriented with its length perpendicular to the prevailing wind.

(ii) For side wall ventilation, the area of clear opening should be not less than 33 per cent of the total sidewall area, distributed over the entire sidewall area.

(iii) Ridge ventilation should be provided if tobacco is cured in the gable.

(iv) Hangers for tobacco on sticks should be horizontal and preferably parallel to the length of the building.

(v) Vertical distance between the floor and the top of the first course of hangers should be 6 ft. 6 in.

(vi) Hangers should be 4 ft. o.c. vertically and 3 ft. 8 in. o.c. horizontally.

(vii) The volume of barn required above the 6 ft. 6 in. plane is 21,600 cu. ft. per acre.

(viii) Two access doors with minimum opening of 12 ft. by 10 ft. should be provided in each end wall.

(b) Stripping-room: The requirements for burley tobacco stripping-rooms are the same as for flue-cured tobacco stripping-room, except that no steam-room is required.

### 1.2.5 Service

**1.2.5.1 Vehicle and Equipment Storage**—

(1) Total floor area requirements for storage of farm vehicles and equipment should be calculated by summing the "occupied areas" of all machines and vehicles for a given farm enterprise, plus 20 per cent for parking clearance. Occupied areas of typical farm machines are listed in Appendix B.

(2) Door openings should be at least 12 in. wider and 4 in. higher than machine transport dimensions as given in Appendix B.

(3) Where doors or other accesses are from one side only, the depth of storage should not be over 28 ft.

(4) Where the maintenance shop area can be used for vehicle storage and where this area meets the requirements of clause 1.2.5.2, up to 50 per cent of the maintenance shop floor area may be counted as storage area for self-propelled farm equipment and vehicles.

**1.2.5.2 Maintenance Shops**—The maintenance shop floor area should

(1) be not less than 20 per cent of the area indicated for vehicle and equipment storage,

(2) be not less than 400 sq. ft., and

(3) have a minimum horizontal inside dimension of 12 ft.

# PART II DESIGN

## 2.1 GENERAL

The requirements of Part II apply to the design and construction of new farm buildings and to the alterations of existing farm buildings.

### 2.1.1 Reference to Good Practice

In this Part where the term "good practice" is used or where such words as "adequate", "sufficient", "suitable", "reasonable" or "effective" or derivatives thereof are used, it is intended to ensure sound, safe construction on the farm.

### 2.1.2 Design

Farm buildings should be designed in accordance with Part 4, "National Building Code of Canada" unless stated otherwise.

**2.1.2.1 Conditions**—The structural members of a farm building should be designed to have sufficient capacity to resist safely and effectively the following

(1) All climatic loads that may probably be applied to them during the expected life of the building.

(2) All loads due to the intended use of the building that may probably be applied to them during the period of that use.

(3) All loads that may reasonably be expected to be applied to them during construction of the building.

(4) All loads due to the materials of construction.

(5) All lateral loads due to earth and water pressure that may reasonably be expected to be applied on any part of the building below ground level.

### 2.1.3 Materials and Building Components

Materials and building components not specifically described in this Part may be used provided their suitability has been established

(1) by test published by a recognized testing laboratory which simulates anticipated service conditions, or

(2) according to recognized engineering principles.

### 2.1.4 Construction Methods

Construction methods should conform to good practice.

### 2.1.5 Drawings and Specifications

Drawings should indicate

(1) the dimensions, location and size of all structural members and connections in sufficient detail to enable the design to be checked,

(2) the loads due to materials of construction in sufficient detail to enable the design to be checked, and

(3) all loads, other than those due to materials of construction incorporated in the building, used in the design of the structural members and connections.

### 2.1.6 Construction Safety Measures

Construction safety measures should conform to Part 8, "National Building Code of Canada", where applicable.

## 2.2 STRUCTURAL LOADS AND PROCEDURES

### 2.2.1 Loads

**2.2.1.1 Loads Due to Materials of Construction**—The minimum design load, due to materials of construction incorporated in a farm building tributary to a structural member is

(1) the weight of the member itself,

(2) the weight of all materials of construction incorporated in the building to be supported permanently by the member, including permanent service equipment, and

(3) the estimated weight of possible future additions.

**2.2.1.2 Loads Due to Use**—The minimum design load on any area of floor, due to the use of the area is listed in Table XV.

TABLE XV

**Floor Loads Due to Use**

| Use of Area of Floor | Design Load psf |
|---|---|
| Cattle | |
| tie stall barns | 70 |
| loose housing (except for bedded area) | 80 |
| slotted floors | * |
| milking parlours | 70 |
| milkrooms or milkhouses | 50** |
| Sheep | 30 |
| Swine | |
| solid floors | 40 |
| slotted floors | *** |
| Horses | 100 |
| Chickens | |
| floor housing | 40**** |
| cages | 40**** |
| Turkeys | 40 |
| Product Storage | ***** |
| Machinery Storage | ****** |
| Greenhouses | 50 |
| Maintenance Shops | 70 |

* See 2.2.1.2(1) "Loads for Beef on Slotted Floors".

** Floor construction under bulk tanks should be designed according to the weight of the tank.

*** See 2.2.1.2(2) "Loads for Swine on Slotted Floors".

**** Where manure is allowed to accumulate, the design load should be increased by 40 psf.

***** The design load for product storage should be calculated on the basis of the individual weights (See Appendix A) but in no case less than 100 psf.

****** See 2.2.1.2(3) "Loads for Machinery Storage".

2.2.1.2

(1) *Loads for Beef Cattle on Slotted Floors*

Loads for beef cattle on slotted floors should be calculated as follows

(a) Assume individual hoof loads of ¼ the animal weight.

(b) Assume distance between an animal's hooves as 1 ft. and the distance between adjacent animals as 2 ft.

(c) Place on the chosen space the maximum number of hoof loads possible.

(d) Arrange the loads to give maximum moment or shear. Maximum shear occurs when two superimposed hoof loads occur at the support.

(2) *Loads for Swine on Slotted Floors*

Loads for swine on slotted floors should be calculated as for beef in clause 2.2.1.2(1) except the hoof distance and distance between animals should be taken as 6 in. and 1 ft. respectively.

(3) *Loads for Machinery Storage*

(a) Machinery Storage (Uniformly Distributed): The minimum design load on an area of floor, due to use of the area as farm machinery storage with traffic limited to access and egress should be 150 psf except where it is anticipated that the area will be occupied by either loaded farm trucks or large farm tractors (large tractors are those having a weight in excess of 13,000 pounds where weight restriction includes effect of mounted equipment) then the design load should be 200 psf.

(b) Machinery Storage (Concentrated): The minimum design loads due to probable concentrations of loads resulting from use of an area of floor is as follows

(i) For Tractors and Implements:—5,000 lb. per wheel at a concentration of 3,600 psf.

(ii) For Loaded Trucks Not Exceeding 20,000 lb. G.V.W.*:—8,000 lb. per wheel at a concentration of 13,000 psf.

(iii) For Loaded Trucks Exceeding 20,000 lb. G.V.W.*: —12,000 lb. per wheel at a concentration of 13,000 psf.

(c) Machinery Storage (Loading and Processing): In cases where the machinery storage area (minimal traffic or driveway) is to serve as a place for loading, unloading or processing, minimum design loads for such areas should be multiplied by a factor of 1.5 due to the weight and impact or vibrations of the piece of machinery or equipment.

(4) *Loads Imposed by Corn and Grass*

(a) Lateral Pressure: Lateral pressure of corn and grass silage with a moisture content not exceeding 75 per cent should

*G.V.W. = Gross Vehicle Weight

**2.2.1.2** (4) (a)

be determined by the formula

$$L = 3.3h^{1.44}$$

in which L = lateral pressure in psf

h = vertical distance in ft. from top of silage to point at which pressure is determined.

This formula is satisfactory for design purposes to a depth of silage of 40 ft. or less. For silos 40 ft. high and above and for silage with a moisture content not exceeding 70 per cent, it is recommended that L = 18h be used for design purposes. (See Appendix C, Figure 1C).

(b) *Vertical Wall Loads:* The vertical wall load of corn and grass silage with a moisture content not exceeding 75 per cent should be determined by the formula

$$f = 5.5h^{1.08}$$

in which f = vertical wall load in psf

h = depth below top of silo in ft.

(5) *Loads Imposed by Stored Grain*

For information relating to loads imposed by stored grain (shallow bins, deep bins, hopper bottoms, exposed horizontal girts, thermal effects, moisture effects, unloading effects (see Appendix C. Physical properties of stored crops are given in Table C-1).

**2.2.1.3 Loads Due to Snow**—Loads due to snow should be in accordance with articles 4.1.2.8. to 4.1.2.11 inclusive of the "National Building Code of Canada".

**2.2.1.4 Loads Due to Wind**—Loads due to wind should be in accordance with articles 4.1.2.12 and 4.1.2.13 of the "National Building Code of Canada".

**2.2.1.5 Loads Due to Rain**—Loads due to rain should be in accordance with article 4.1.2.14 of the "National Building Code of Canada".

### 2.2.2 Design Procedures

**2.2.2.1 Allowable Stresses**—The following clauses are designed to permit farm building design with a reduced overall safety factor in recognition of low risk to human life and low value of contents or low risk to loss of contents.

(1) For purposes of structural design, "low hazard" farm buildings include any buildings other than those intended for high human occupancy. Buildings with high human occupancy include processing rooms, workshops or other work or rest areas likely to be occupied by several persons over extended periods, particularly during the winter.

(2) For the structural design of "low hazard" farm buildings, the allowable stresses in tension, compression, bending, and shear as set forth in the "National Building Code of Canada" may be increased by 25 per cent in elements designed to support climatic loadings.

**2.2.2.1**

(3) For the structural design of farm buildings other than "low hazard" buildings, the allowable stresses in tension, compression, bending, and shear as set forth in the "National Building Code of Canada" may be increased by 10 per cent in elements designed to support climatic loadings except where probable occupancies will include the assembly of large numbers of people such as auction or show arenas and large-scale processing rooms or workshops.

(4) Increases in allowable stresses for farm buildings in accordance with clauses 2.2.2.1(2) and 2.2.2.1(3) may be applied in addition to other modification factors for applicable conditions provided for in the "National Building Code of Canada."

**2.2.2.2 Deflections—**

(1) Except where plaster, ceramics or other brittle materials form part of the assembly subject to deflection, the deflection of trusses, beams, floor and roof systems, and similar structural components for farm structures generally need not conform to any specific limitations.

(2) Deflections should be taken into account in the design, based on live load and dead load, to ascertain that deflection under design load will not cause interference with the operation of doors, windows or equipment.

(3) Where plaster, ceramics or other brittle materials form part of the assembly subject to deflections, the deflection should be limited to 1/360 of the span, based on live load only.

## 2.3 FOUNDATIONS

### 2.3.1 General

(1) Farm buildings should be adequately supported by foundations.

(2) Foundations should be interpreted to include footings and piling, walls, posts, piers, pilasters, rafts, slabs, grade beams, grillages or design forms which extend below grade for the purpose of supporting the farm building on the ground.

(3) Foundations should be designed

(a) for the existing soil according to recognized engineering principles, or

(b) on the basis of past experience with the soil conditions where the foundation is to be built.

(4) Vertical loads should be provided for in the design through the distribution of the load to the soil by compression or skin friction. Design for skin friction should be in accordance with article 4.2.2.12 of the "National Building Code of Canada."

### 2.3.2 Footings

**2.3.2.1 General—**

(1) Except as permitted in sentence (4) below, footings should

be provided under foundations walls, columns, piers, and poles to distribute the loads in accordance with the allowable bearing values of the supporting material in Table XVI.

(2) The bearing surface on gravel, sand or silt shall not be less than 1 ft. below grade; however, where this surface is more than 1 ft. below grade and is embedded on all sides by the same soil, the maximum design bearing pressure of the soil is that listed in Table XVI increased at the rate of 20 per cent for each foot increase in depth but not more than 200 per cent.

(3) Where a foundation bears on gravel, sand or silt, and where the highest level of the ground water is, or is likely to be, higher than an elevation defined by the bearing surface less the width of the footing, the maximum bearing pressure shall be 50 per cent of that determined in sentences (1) and (2) above.

**TABLE XVI**

**Design Bearing Pressures of Soils and Rocks**

| Type and Condition of Soil or Rock | Design Bearing Pressure, psf |
|---|---|
| Cohesionless Soils— | |
| dense sand, dense sand-and-gravel | 6,000 |
| *Cohesive Soils— | |
| dense silt | 3,000 |
| medium dense silt | 2,000 |
| hard clay | 6,000 |
| stiff clay | 4,000 |
| firm clay | 2,000 |
| soft clay | 1,000 |
| Miscellaneous Soils and Rock— | |
| till, dense | 10,000 |
| cemented sand-and-gravel | 20,000 |
| clay-shale—(special investigation required since insufficient load may cause problems) | ..... |
| Rock— | |
| massive | 100,000 |
| foliated | 80,000 |
| sedimentary | 40,000 |
| soft or shattered | 20,000 |

* A cohesive soil described as
*hard* is a soil impossible to indent with the thumb but readily indented with the thumbnail
*stiff* is a soil difficult to indent with the thumb; with difficulty it can be remoulded by hand
*firm* is a soil that can be indented by moderate thumb pressure, and
*soft* is a soil that can be penetrated several inches with the thumb.

(4) Footings may be omitted if the safe bearing capacity of the soil or rock is not exceeded.

**2.3.2.1**

(5) Footings should be proportioned to minimize differential settlement.

(6) If footings are to be supported on consolidated fill or unstable soil, they should be designed for these conditions and the building so constructed that it will not be structurally damaged by settlement.

**2.3.2.2 Concrete Footings for Concrete, Masonry or Stone Walls—**

(1) *General*

(a) Wall footings should be proportioned from the soil-bearing pressures and applied loads to minimize non-uniform settlement.

(b) The bottom of footings should be below frost line except when on rock or on coarse grain soil, well drained to at least the depth of frost penetration.

(2) *Plain Footings*

(a) The minimum thickness of plain footings should be the minimum thickness of foundation walls prescribed in clause 2.3.3.1(3).

(b) The minimum width of plain footings should be the actual thickness of the supported foundation walls increased by the minimum thickness of foundation walls prescribed in clause 2.3.3.1(3).

(3) *Steel Reinforced Footings*

The minimum thickness of steel reinforced footings should be 9 in.

**2.3.2.3 Concrete Footings for Columns and Poles**—Column footings should be of sufficient size to carry the concentrated loads they must support.

(1) The minimum thickness of unreinforced column footings should be 8 in.

(2) Column footings more than 3 ft. sq. should be reinforced except where the thickness of the footing is equal to or greater than the greatest distance from the edge of the column to the edge of the footing.

(3) Precast pads for pole construction should not be used.

(4) Backfill around poles should be tamped.

**2.3.2.4 Wood Footings for Wood or Metal Walls Columns, Posts or Poles—**

(1) The minimum thickness of wood used in footings should be 1½ in.

(2) Wood footings should be designed so as not to exceed the allowable unit stresses specified in subsection 2.4.2 for the grade and species used.

(3) Wood footings should be treated in accordance with subsection 2.4.3

### 2.3.3 Foundation Walls

**2.3.3.1 Concrete and Unit Masonry Foundation Walls—**

(1) Foundation walls should be designed to resist vertical and horizontal loads taking into account their unsupported length and height.

(2) Except as provided for in sentence (3), the minimum thickness of foundation walls should be 8 in.

(3) *Minimum Thicknesses*

(a) For buildings measuring less than 100 sq. ft. in floor area and with superstructure walls less than 8 ft. in height, the minimum thickness should be 6 in.

(b) The minimum thickness of foundation walls should be 10 in. when

(i) the walls extend more than 4 ft. into unstable and poorly drained soils,

(ii) the walls extend more than 7 ft. into the ground,

(iii) the total height of foundation and superstructure bearing walls is more than 24 ft. but less than 35 ft. (see subsection 2.5.2(1)(d)).

(c) The minimum thickness of foundation walls should be 12 in. when the total height of foundation and superstructure bearing walls is more than 35 ft.

(4) Foundation walls should extend at least 6 in. above ground.

(5) All exterior surfaces of basement or cellar walls below grade should be waterproofed below grade by

(a) parging the wall below finish grade with cement mortar at least 3/8 in. thick and coving the parging over the footing if the foundation consists of unit masonry,

(b) filling the recesses resulting from the removal of form ties with cement mortar or sealing the recesses with waterproofing material if the foundation wall is of solid concrete, and

(c) covering the walls with two coats of hot bituminous material or portland cement base paint.

**2.3.3.2 Wood Frame Foundation Walls—**

(1) Wood frame foundation walls should be designed to resist vertical and horizontal loads taking into account their unsupported length and height.

(2) All horizontal and vertical framing, and plywood or lumber sheathing should be treated in accordance with subsection 2.4.3 below grade and to a minimum height of 12 in. above grade.

**2.3.3.3 Backfilling**—Backfill should be placed carefully against the foundation walls to avoid damaging the walls or injuring any waterproofing, and to a level sufficiently above the finish grade so that future settlement of the backfill will not cause the final grade to slope towards the foundation.

### 2.3.4 Concrete Grade Beam Foundations

A concrete grade beam foundation consists of a series of concrete piers that support a reinforced beam around the perimeter of the building.

**2.3.4.1 Piers—**

(1) Piers should be proportioned to carry all vertical loads and should be reinforced to resist lateral forces and tensile stresses. The minimum cross sectional area of steel should be 0.01 times the cross sectional area of the piers.

(2) The bottom of piers should have sufficient bearing area to distribute safely the loads over the supporting soil.

(3) Piers should extend below frost line to firm bearing.

(4) The minimum diameter of piers should be 10 in.

**2.3.4.2 Grade Beams**—Grade beams should be designed to carry the live and dead loads of the building supported by the walls and should extend at least 8 in. above grade.

### 2.3.5 Wood Post and Plank Foundations

(1) Wood post and plank foundations should be designed to resist vertical and horizontal loads, taking into account their unsupported length and height.

(2) Both planks and posts should be treated in accordance with subsection 2.4.3 below grade and to a minimum height of 12 in. above grade.

### 2.3.6 Concrete Slabs on Grade

**2.3.6.1 Slabs on Grade (with Perimeter Foundation Walls)—**

(1) A minimum of 4 in. of compacted granular material should be provided underneath slabs.

(2) The minimum thickness of concrete slabs on grade should be 4 in.

(3) The tops of slabs should be at least 6 in. above exterior finish grade.

(4) Uniformly distributed reinforcement for slabs on grade should weigh not less than 40 lb. per 100 sq. ft.

(5) Footings for load-bearing partitions should rest on undisturbed soil. The minimum thickness of such footings should be 5 in. measured from the underside of the slabs on grade and their minimum width should be 12 in.

**2.3.6.2 Slabs on Grade (Without Perimeter Foundation Walls)—**

(1) The requirements for floating slabs should not be less than those for slabs on grade with foundation walls.

(2) The tops of slabs should be at least 12 in. above exterior finish grade.

**2.3.6.2**

(3) A tapered perimeter beam should be provided with a minimum width at the base of 8 in. The beam should extend not less than 12 in. into undisturbed soil.

### 2.3.7 Wood Sills and Skirting

**2.3.7.1 Wood Sills—**

(1) Wood sills should have a minimum thickness of 1½ in.

(2) Wood sills on or below grade should be treated in accordance with subsection 2.4.3.

**2.3.7.2 Wood Skirting**—Lumber or plywood skirting should be treated in accordance with subsection 2.4.3 below grade and to a minimum height of 12 in. above grade.

### 2.3.8 Drainage

**2.3.8.1 General—**

(1) In wet areas, foundations should be drained by placing a drain tile line beside the footings and around the exterior side of foundations so that the top of the pipe is below the bottom of the slab.

(2) The drain tile line should carry the water away from foundations to an outlet that always remains open.

(3) An open joint of between ¼ in. and ⅜ in. should be provided between each drain tile and a cover strip or coarse gravel should be placed over at least the top half perimeter of the open joints.

(4) A minimum of 2 ft. of granular material should be placed over the tile to facilitate movement of the water into the drain.

**2.3.8.2 Slabs Below Grade**—Where ground water levels may cause periodic water penetration through the slab, lateral drains should be installed under the slab.

**2.3.8.3 Slabs on Grade**—The accumulation of water underneath a slab on grade should be prevented by grading, drainage or other method.

## 2.4 WOOD

### 2.4.1 General

Except as otherwise provided for in this Section, the design or appraisal of farm buildings or structural elements made from wood or wood products should be in accordance with Section 4.3, "National Building Code of Canada".

### 2.4.2 Allowable Unit Stresses

(1) For purposes of assigning allowable unit stresses, species are classified according to groups given in Table XVII.

**2.4.2** (1)

TABLE XVII

Species Groups

| Group | Species |
|---|---|
| I | (a) Douglas Fir (dense)<br>(b) Douglas Fir, Western Larch<br>(c) Pacific Coast Hemlock |
| II | Pacific Coast Cypress<br>Eastern Larch (Tamarack)<br>Jack Pine |
| III | Fir (Amabilis and Grandis)<br>Balsam Fir<br>Eastern Hemlock<br>Pine (Lodgepole and Ponderosa)<br>Spruce (all species) |
| IV | Western Red Cedar<br>Pine (Red)<br>Pine (Western and Eastern White)<br>Poplar (Aspen, Large-toothed Aspen, and Balsam only) |

(2) Structurally graded lumber may be assigned allowable unit stresses in accordance with article 4.3.5.5 of the "National Building Code of Canada."

(3) All structurally graded lumber assigned allowable unit stresses should be identified by a grade mark of an inspection agency approved by the CLS Administrative Board of the Canadian Standards Association.

(4) Graded lumber used in load-sharing systems may be assigned allowable unit stresses in bending in accordance with Table XVIII provided that it is identified by the appropriate grade mark of an inspection agency approved by the CLS Administrative Board of the Canadian Standards Association.

"*Load-sharing systems*" *means a construction composed of three or more essentially parallel members spaced at 24 in. centres or less, so arranged or connected that they mutually support the load.*

Reference should be made to article 4.3.3.3 of the "National Building Code of Canada" for further information on modification of allowable unit stresses.

(5) Allowable stress modification factors for farm buildings may be applied to values from Table XVIII in accordance with clause 2.2.2.1.

## TABLE XVIII

### Allowable Unit Stresses In Bending, For the Various Species And Grades of Lumber, For Load-Sharing Systems, For Normal Duration Of Load* and Dry Service Conditions.

| Grading Rule | Grade | Nominal** Size (inches) | Strength Groups and Allowable Unit Stresses in p.s.i. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | I (a) 2050 | I (b) 1900 | I (c) 1600 | II 1500 | III 1300 | IV 1150 |
| British Columbia Lumber Manufacturers Association Rules No. 59 as amended up to May 3, 1962 (Supplements I to III) | Select Structural | 2 x 4 | 2255 | 2090 | 1760 | | | |
| | | 2 x 6 | " | " | " | | | |
| | | 2 x 8 | " | " | " | | | |
| | | 2 x 10 | " | " | " | | | |
| | | 2 x 12 | " | " | " | | | |
| | Select Merchantable | 2 x 4 | — | — | — | 1240 | 1070 | 950 |
| | | 2 x 6 | | | | 1420 | 1230 | 1090 |
| | | 2 x 8 | | | | 1500 | 1300 | 1150 |
| | | 2 x 10 | | | | 1560 | 1350 | 1200 |
| | | 2 x 12 | | | | 1600 | 1390 | 1230 |
| West Coast Lumber Inspection Bureau Rules No. 15 Revised Edition— May 1, 1962 | Construction | 2 x 4 | 980 | 910 | 770 | 720 | 620 | 550 |
| | | 2 x 6 | 1925 | 1650 | 1650 | 1020 | 880 | 780 |
| | | 2 x 8 | " | " | " | 1200 | 1040 | 920 |
| | | 2 x 10 | " | " | " | 1200 | 1040 | 920 |
| | | 2 x 12 | " | " | " | 1200 | 1040 | 920 |
| Western Pine Association Rules 1961, as amended up to April 1, 1962 (Supplements 1 to 4) | Standard | 2 x 4 | — | — | — | — | — | — |
| | | 2 x 6 | | 1320 | 1320 | 640 | 550 | 490 |
| | | 2 x 8 | | " | " | 740 | 640 | 570 |
| | | 2 x 10 | | " | " | 800 | 690 | 610 |
| | | 2 x 12 | | " | " | 900 | 780 | 690 |
| Western Pine Association Rules 1961, as amended up to April 1, 1962 (Supplements 1 to 4) | Utility | 2 x 4 | | — | — | — | — | — |
| | | 2 x 6 | | — | — | — | — | — |
| | | 2 x 8 | | 730 | 620 | 580 | 500 | 440 |
| | | 2 x 10 | | 860 | 730 | 680 | 590 | 520 |
| | | 2 x 12 | | 810 | 680 | 640 | 550 | 490 |
| O43-1953 C.S.A. Specification for Structural Timber | Select Structural | 2 x 4 | | | | 1650 | 1430 | 1265 |
| | | 2 x 6 | | | | " | " | " |
| | | 2 x 8 | | | | " | " | " |
| | | 2 x 10 | | | | " | " | " |
| | | 2 x 12 | | | | " | " | " |
| | Structural | 2 x 4 | | | | 1320 | 1155 | 990 |
| | | 2 x 6 | | | | " | " | " |
| | | 2 x 8 | | | | " | " | " |
| | | 2 x 10 | | | | " | " | " |
| | | 2 x 12 | | | | " | " | " |
| Eastern Spruce Grading Committee Rules as published by the Maritime Lumber Bureau and the Quebec Lumber Mfrs. Assoc. May, 1961 and Canadian Lumbermen's Association Rules October, 1960, as amended up to March 1, 1962 | Selected Merchantable | 2 x 4 | | | | 1240 | 1070 | 950 |
| | | 2 x 6 | | | | 1620 | 1400 | 1240 |
| | | 2 x 8 | | | | 1500 | 1300 | 1150 |
| | | 2 x 10 | | | | 1440 | 1250 | 1100 |
| | | 2 x 12 | | | | 1600 | 1390 | 1230 |
| | No. 1 (Construction) | 2 x 4 | | | | 720 | 620 | 550 |
| | | 2 x 6 | | | | 1200 | 1040 | 920 |
| | | 2 x 8 | | | | 1200 | 1040 | 920 |
| | | 2 x 10 | | | | 1200 | 1040 | 920 |
| | | 2 x 12 | | | | 1380 | 1200 | 1060 |
| Eastern Spruce Balsam Fir Jack Pine Eastern Hemlock Poplar Tamarack | No. 2 (Standard) | 2 x 4 | | | | — | — | — |
| | | 2 x 6 | | | | 900 | 780 | 690 |
| | | 2 x 8 | | | | 1060 | 920 | 810 |
| | | 2 x 10 | | | | 1080 | 940 | 830 |
| | | 2 x 12 | | | | 1300 | 1130 | 1000 |

TABLE XVIII (Cont'd)

| Grading Rule | Grade | Nominal** Size (inches) | Strength Groups and Allowable Unit Stresses in p.s.i. | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | I (a) 2050 | I (b) 1900 | I (c) 1600 | II 1500 | III 1300 | IV 1150 |
| Canadian Lumbermen's Association Rules October, 1960 (for White and Red Pine) as amended up to March 1, 1962 | No. 1 | 2 x 4 | | | | — | — | 950 |
| | | 2 x 6 | | | | | | 920 |
| | | 2 x 8 | | | | | | 920 |
| | | 2 x 10 | | | | | | 920 |
| | | 2 x 12 | | | | | | 1060 |
| | Merchantable and No. 2 | 2 x 4 | | | | — | — | 750 |
| | | 2 x 6 | | | | | | 780 |
| | | 2 x 8 | | | | | | 810 |
| | | 2 x 10 | | | | | | 830 |
| | | 2 x 12 | | | | | | 1000 |
| Canadian Lumbermen's Association Rules October 1960 (for White and Red Pine) as amended up to March 1, 1962 | No. 1 Dimension | 2 x 4 | | | | — | — | 550 |
| | | 2 x 6 | | | | | | 690 |
| | | 2 x 8 | | | | | | 740 |
| | | 2 x 10 | | | | | | 830 |
| | | 2 x 12 | | | | | | 920 |
| Eastern Pine Grading Committee Rules for Red and White Pine as published by the Maritime Lumber Bureau and Quebec Lumber Mfrs. Assoc., effective August 1, 1962 | No. 2 Dimension | 2 x 4 | | | | — | — | — |
| | | 2 x 6 | | | | | | 410 |
| | | 2 x 8 | | | | | | 440 |
| | | 2 x 10 | | | | | | 520 |
| | | 2 x 12 | | | | | | 570 |

* Allowable unit stresses for roof joists and roof rafters are increased 15 per cent above these values.

** Spans for sizes not listed in the table (2 x 5, 2 x 7, etc.), may be estimated with sufficient accuracy by straight line interpolation.

(6) Ungraded lumber should not be used in applications where the calculation of unit stresses is essential to the design.

### 2.4.3 Wood Preservation

(1) Wood in contact with earth, manure packs or deep poultry litter should be pressure-treated with an effective wood preservative, except that untreated cedar or other species of poles treated by recognized non-pressure processes may be used where local experience has proven this to be satisfactory.

(2) The use of toxic preservatives should be avoided in areas in contact with or above fruit, vegetables, or grain.

(3) Wood that has been pressure-treated in accordance with the requirements of CSA Specification "Wood Preservation", 080-1962, published by the Canadian Standards Association, may be in continuous contact with masonry or concrete when moisture conditions which favour decay are present.

(4) All boring, grooving, cutting and other possible fabrication should be completed before treatment.

(5) All fabrication carried out after treatment should be locally treated in accordance with CSA Specification "Wood Preservation", 080-1962, published by the Canadian Standards Association.

### 2.4.4 Structural Assemblies

(1) Structural assemblies may be designed in accordance with the relevant clauses of Section 4.3, "National Building Code of Canada", or may be evaluated on the basis of load tests.

(2) Where the design of structural assemblies is based upon load tests, representative sample assemblies selected at random should be capable of supporting

(a) 100 per cent of design dead and live loads for one hour without exceeding deflection limitations where applicable, and

(b) 100 per cent of design dead load plus 200 per cent of design live load for 24 hours without failure.

### 2.4.5 Glued Structural Assemblies

(1) Glued structural assemblies including glulam, should be either exterior or interior grade as required to meet the service conditions.

(2) Interior grade may be used where the equilibrium moisture content in service will average 15 per cent or less over any year.

(3) Exterior grade should be used for all other service conditions, including those buildings where the interiors are subjected to high relative humidity or free water.

### 2.4.6 Plywood

(1) Plywood used for floors or roofs should be applied with the face grain perpendicular to the supports and with joints which are parallel to the supports staggered.

(2) Plywood used for wall sheathing, exterior cladding, or interior finish on walls or ceilings should be exterior type and be applied so that all adjacent panel edges are separated by 1/16 in. or lapped.

## 2.5 UNIT MASONRY

### 2.5.1 General

Except as provided for in this Section, the design of unit masonry should conform to the requirements in Part 4, Section 4.4, of the "National Building Code of Canada".

### 2.5.2 Allowable Heights and Minimum Wall Thicknesses

(1) The minimum thickness of load-bearing solid masonry walls not exceeding 36 ft. in height should be

(a) 8 in. for the top 20 ft.,

(b) 10 in. for that portion more than 20 ft. but less than 36 ft. from the top,

(c) 4 in. for buildings measuring less than 100 sq. ft. of floor area and with superstructure walls less than 8 ft. in height, and

(d) 12 in. for below grade walls extending more than 7 ft. into the ground.

**2.5.2**

(2) The minimum thickness of load-bearing cavity walls not exceeding 25 ft. in height should be 10 in.

(3) The minimum thickness of non-load-bearing partition solid masonry walls not more than 12 ft. in height should be 4 in.

**2.5.3 Lateral Support**

(1) Every masonry wall should be supported at right angles to the wall face either horizontally by means of floor or roof systems or vertically by means of pilasters or crosswalls.

(2) The maximum distance between lateral supports should be

(a) 18 times the wall thickness for load-bearing walls,

(b) 36 times the wall thickness for non-load-bearing walls.

**2.5.4 Lintels**

Concrete lintels should bear at least 8 in. on the wall on each side of openings.

**2.5.5 Roof Anchorage**

Roofs should be securely anchored to masonry walls to prevent lifting from high winds.

**2.5.6 Mortar**

See Appendix D, Table D-I for recommended mortar mixes.

**2.5.7 Laying**

(1) All masonry should be built true and plumb.

(2) Concrete masonry units should be dry when laid and each unit should be properly embedded in mortar. Joints should be tooled.

**2.5.8 Insulation and Surface Protection**

(1) When granular insulation is used in conjunction with masonry units, the warm side of the walls should be sealed with a vapor sealing material. The outside of walls should also be protected to keep out wind-driven rains.

(2) When rigid insulation is used and is exposed, it should be covered with a protective plaster coat or other suitable material.

**2.6 CONCRETE**

**2.6.1 General**

Except as otherwise provided in this Section the design or appraisal of farm buildings or structural elements made from concrete or concrete products should be in accordance with Section 4.5, "National Building Code of Canada".

**2.6.2 Air Entrained Concrete**

Air entrained concrete should be used for all concrete that will be exposed to freezing and thawing and to the use of de-icing agents

### 2.6.3 Ready-Mixed Concrete

Ready-mixed concrete should conform to the requirements of CSA Specification, "Concrete Materials and Methods of Concrete", A23-1, published by the Canadian Standards Association. (See Appendix D, D-II for guide for ordering ready-mixed concrete).

### 2.6.4 On-Site Mixing

See Appendix D, Table D-III for recommended mixes for on-the-job mixing.

### 2.6.5 Concrete Floors

(1) The minimum thickness of floors should be 4 in.

(2) *Subgrade*

(a) The subgrade should be free of sod, large stone, organic matter, mud and debris and should provide uniform support under the floor.

(b) Fill material should be placed in 6-in. layers and should be well compacted.

(3) *Joints*

Floors should be prevented from bonding to foundation walls, columns or other rigid parts of buildings.

(4) *Watertight floors*

(a) A minimum of 4 in. of granular material with particle size not smaller than ¼ in. nor larger than 2 in. should be placed over the subgrade.

(b) A vapour barrier of adequate strength to prevent puncturing should be laid over the granular material mentioned in (a) with a minimum of 4-in. laps between the strips.

### 2.6.6 Concrete Pavements

(1) The minimum thickness of pavements should be 4 in.

(2) When drainage is required, a minimum slope of ¼ in. per ft. should be provided.

(3) Joints should be provided to control cracking.

### 2.6.7 Concrete Silo

#### 2.6.7.1 Foundations—

(1) The minimum thickness of foundation walls should be 6 in.

(2) Foundation walls should be reinforced to withstand the lateral pressure of the silage.

#### 2.6.7.2 Footings—

(1) Footings should be designed to carry the weight and friction loads of silos.

(2) The width and depth of plain annular footings should be in accordance with ACI Standard "Recommended Practice for the

**2.6.7.2** (2)

Construction of Concrete Farm Silos", 714-46, published by the American Concrete Institute.

**2.6.7.3 Hoops**—The maximum hoop spacing should be 30 in.

**2.6.7.4 Stave Silos**—

(1) Staves should meet the requirements of ACI Standard "Recommended Practice for the Construction of Concrete Farm Silos", 714-46, published by the American Concrete Institute.

(2) Stave silos should be airtight and should resist the action of silage acid.

**2.6.7.5 Cast-in-Place Silos**—

(1) The minimum wall thickness should be 5 in. except that if external hooping is used the minimum thickness should be 4 in.

(2) When embedded reinforcement is used, it should be protected by a minimum concrete cover of 2 in.

## 2.7 STEEL

The design of farm buildings or structural elements made from steel products should be in accordance with Sections 4.6 and 4.7 of the "National Building Code of Canada".

## 2.8 ALUMINUM

The design of farm buildings or structural elements made from aluminum products should conform to CSA Specification "The Structural Use of Aluminum in Buildings", S157-1962, published by the Canadian Standards Association, and with Section 4.7 of the "National Building Code of Canada".

## 2.9 VAPOUR BARRIERS

### 2.9.1 Materials

Materials should conform to requirements for Type I Vapour Barrier in accordance with CGSB Specification "Vapour Barriers; Sheet, for use in Above-Grade Building Construction", 70-GP-1, 8 July, 1960, published by the Canadian Government Specifications Board, or otherwise provide permanent resistance to the passage of water vapour of .25 perms or less when applied.

### 2.9.2 Installation

(1) Vapour barriers should be installed on the warm side of all insulated assemblies as near to the surface as possible if insulation is used that is a type which, when installed, does not effectively limit the passage of water vapour over the entire surface.

(2) All joints should be located over supporting members and lap at least 1 in.

(3) The entire surface, including framing members, should be protected with the vapour barrier so that no gaps occur.

(4) Openings should be cut in such a manner that the vapour

**2.9.2** (4)

barrier fits snugly around electrical outlets, water pipes, etc., without damaging the insulation.

(5) Damaged vapour barriers should be repaired or replaced.

## 2.10 INSULATION

### 2.10.1 General

(1) Insulation should be installed in agricultural buildings where required to establish a heat balance between that produced by the animals or materials contained in the structure and the heat lost through the walls, floors and ceilings (see Tables on heat production in Appendices F and G) and to prevent condensation.

(2) Insulation should be provided between heated and unheated spaces and around the perimeter of concrete slabs on grade.

### 2.10.2 Thermal Conductivities

Values used in calculating "U" values may be found in "The Guide", published annually by the American Society of Heating, Refrigerating and Air Conditioning Engineers.

### 2.10.3 Materials

(1) Insulating materials should conform to the following specifications

"Cork; Thermal, Insulation Board", Fed. Spec. HH-I-525, 11 April 1960; and "Cork, Granulated, Insulating", Fed. Spec. HH-C-57la, 6 June, 1933, published by the U.S. General Services Administration;

"Mineral Wool Thermal Building Insulation", CSA A101-1952, published by the Canadian Standards Association;

"Fibreboard; Insulating", CGSB 11-GP-2, 1960, published by the Canadian Government Specification Board.

(2) Materials used for insulation that is in contact with the ground should be inert to the action of soil and water. The insulating property should not be reduced significantly by moisture.

(3) Materials such as straw should be used for short term insulation only, because of their moisture absorption properties.

(4) Damaged insulation should be repaired or replaced.

### 2.10.4 Methods of Installation

(1) Insulation should be installed in such a manner that there is a reasonably uniform insulating value over the entire face of the insulated area.

(2) Insulation should occupy the full width and length or height of the space between furring or framing members when applied therein.

(3) Loose fill insulation should be used on horizontal surfaces

**2.10.4** (3)

only in new buildings except that purpose-designed granular types are acceptable for cavity wall construction in the cavity between the outer and inner wythes.

(4) Insulation of foundation walls enclosing heated buildings and in buildings where heat loss is critical, should extend at least 12 in. below adjacent grade.

(5) Insulation around concrete slabs on grade should extend at least 6 in. below exterior grade and be located so that heat is not restricted from reaching the ground beneath the perimeter if exterior walls are not supported by footings extending below frost level.

(6) Where insulation would be exposed to the weather and subject to mechanical damage, it should be protected.

## 2.11 CLADDING

The design, properties and application of cladding for farm buildings should be in accordance with Section 4.7, "National Building Code of Canada".

# PART III BUILDING SERVICES

## 3.1 TEMPERATURE AND HUMIDITY

This Section applies to the range of temperature and humidity conditions in farm buildings associated with production and storage.

(1) The maximum and minimum inside temperatures and relative humidities for animal production buildings should be as shown in Table XIX.

**TABLE XIX**

**Recommended Temperature and Humidity Limits for Closed Animal Production Buildings**

| Animal | Inside Temp. °F. | | Inside Relative Humidity % | |
|---|---|---|---|---|
| | Min. | Max. | Min. | Max. |
| Dairy Cattle | 35 | 75 | 25 | 75 |
| Beef Cattle | 32 | 60 | 25 | 75 |
| Sheep and Goats | NA* | NA | NA | NA |
| Swine | 40 | 90 | 25 | 75 |
| Poultry and Rabbits | 32 | 85 | 50 | 75 |
| Horses | 32 | 85 | 25 | 75 |

* Not applicable.

(2) The minimum and maximum inside temperatures and humidities for product storage should be as given in Table XX.

**TABLE XX**

**Temperatures and Humidities for Product Storage**

| Product | Storage Temp. | | Storage Rel. Humidity |
|---|---|---|---|
| | Min. °F. | Max. °F. | % |
| **Fruits—** | | | |
| Apples | 30 | 45 | 90 |
| Blackberries | 32 | 40 | 90 |
| Blueberries | 32 | 40 | 90 |
| Cherries | 32 | 45 | 90 |
| Cranberries | 36 | 40 | 90 |
| Gooseberries | 32 | 40 | 90 |
| Grapes | 32 | 45 | 90 |
| Honey Dew Melon | 32 | 45 | 90 |
| Peaches | 32 | 33 | 90 |
| Pears | 30 | 31 | 95 |
| Plums | 32 | 33 | 90 |
| Raspberries | 32 | 40 | 90 |
| Strawberries | 32 | 40 | 90 |
| **Vegetables—** | | | |
| Asparagus | 32 | 40 | 95 |
| Beans, string | 45 | 50 | 90 |
| Beans, Lima | 32 | 45 | 90 |
| Broccoli | 32 | 45 | 95 |
| Cabbage | 32 | 45 | 95 |
| Carrots | 32 | 45 | 95 |
| Cauliflower | 32 | 40 | 95 |
| Celery | 32 | 33 | 95 |
| Cucumbers | 45 | 50 | 90 |
| Lettuce | 32 | 45 | 95 |
| Onions | 32 | 45 | 70 |
| Parsnips | 32 | 45 | 95 |
| Peas (green) | 32 | | 90 |
| Potatoes (white) | | | |
| —process | 50 | 55 | 90 |
| —table | 40 | 55 | 90 |
| —seed | 36 | 40 | 90 |
| Spinach | 32 | 33 | 95 |
| Tomatoes (ripening) | 55 | 65 | 90 |
| Turnips | 32 | 35 | 90 |
| Eggs | 50 | 60 | 70 |

(3) The removal of field heat should be accomplished in the shortest time possible to adjust to recommended storage temperature with the exception of potatoes which should be allowed to suberize at higher temperatures.

(4) Building surfaces should be provided with sufficient insulation to prevent condensation under the outside design temperatures and recommended inside humidities prevailing.

## 3.2 VENTILATION

This Section deals with the movement of air within farm buildings for the control of temperature, humidity and air contaminants.

### 3.2.1 General

(1) The outside winter design temperatures for ventilating should be determined on a 5 per cent basis (see Appendix E).

(2) Ventilation requirements for livestock structures should be based on the inside-outside temperature differentials, and the heat and moisture production relationship of the livestock. (See Appendix F).

(3) Ventilation requirements for fruit and vegetable storage should be based on the inside-outside temperature differentials, field heat and heat of respiration of stored products. (See Appendix G).

(4) Greenhouse ventilation systems should be capable of providing 15 air changes per hour for spring and fall weather conditions. For summer conditions greenhouses should be provided with 10 cfm per sq. ft. of greenhouse floor area plus evaporative cooling.

(5) Except when mechanical ventilation is provided, natural ventilation should be provided by means of openable windows, flues, shutters or louvres.

### 3.2.2 Ventilation Systems

(1) All ventilating equipment should be CSA approved and be installed in accordance with relevant CSA specifications.

(2) Design of ducts, air inlets, grilles, fans and power units should be carried out in accordance with good engineering practice. (See Appendix H for resistance of grains and seeds to air flow).

(3) Exhaust fans which are not connected to a duct system should be selected on the basis of delivery at not less than ⅛-in. water static pressure.

(4) Shutter should be provided on exhaust fans.

(5) Where wind conditions dictate, exhaust fans installed in a wall should be hooded to 6 in. below base of fan.

(6) Thermostats for fan control should be located in an area free of potential mechanical damage and so placed that they will sense average ambient conditions.

(7) Fresh air inlets should be arranged to prevent direct drafts on livestock.

(8) Fresh air inlets should be shielded from snow and rain and should be fitted with a corrosion-resistant screen.

(9) Fresh air inlets should be separated from exhaust fans by at least 10 ft.

(10) Where fuels are burned in greenhouses, a separate combustion air and flue system should be provided.

(11) For machine repair shops, see subsection 1.1.3(2).

## 3.3 HEATING AND REFRIGERATION

### 3.3.1 General

All heating and refrigeration equipment should be CSA approved and be installed in accordance with relevant CSA specifications published by the Canadian Standards Association.

### 3.3.2 Heating

(1) Sufficient insulation should be provided in accordance with Section 2.10 in walls and ceilings of farm buildings (except greenhouses) to permit the maintenance of recommended minimum inside temperatures and to prevent condensation. Where this is not feasible, supplemental heat should be provided.

(2) In greenhouses where fuels are burned, fresh air inlets should be provided at the rate of 50 sq. in. for every 100,000 BTU of fuel input.

(3) Movable gas-fired brooders and heaters for poultry should be connected to the fuel supply pipe with not more than 8 ft. of flexible hose.

(4) Where forced-air heating systems are used in poultry houses and other dusty buildings, the cold air return duct should be equipped with a filter, the area of which should be at least 4 times greater than normally used in domestic forced air furnaces.

### 3.3.3 Refrigeration

The size of refrigeration systems and equipment for fruit and vegetable storage should be determined on the basis of heat of respiration, field heat (at time of harvest) and desired cooling rate, and heat gain and losses from other sources and relative humidity.

## 3.4 ELECTRICAL SERVICES

This Section applies to the electrical services in farm buildings.

### 3.4.1 Pole Metering

**3.4.1.1 Equipment on the Meter Pole**—Most power suppliers will furnish drawings for various capacities of pole meter installations.

**3.4.1.2 Disconnecting Means on Meter Pole**—Where local regulations require overcurrent protection on the meter pole, consideration should be given to multiple protective devices so that trouble on one feeder does not interrupt all service to the farmstead.

**NOTE**

A separate switch or breaker should serve the water pump.

*"Feeder" means the conductor extended from a distribution panel in one building to the service entrance conductor of another building or from distribution panel to branch circuit panel in the same building. For design purposes, the term "Feeder" will also be applied to the service drop conductors which connect a pole-meter installation to the service entrance conductors of the various buildings served from the meter pole.*

**3.4.1.3 Service Drops or Feeders from Meter Pole to Buildings—**

(1) When the service drop from meter pole to a building must also supply other buildings connected to feeders from the first building, then the maximum demand on this service drop should be based on 100 per cent of the largest demand among the group of buildings plus 50 per cent of the sum of the demands in the other buildings.

(2) Service drops or feeders selected should be the larger size determined by either the connected load both present and future or the voltage drop.

(3) The size and type of wire required for a 115/230-volt 3-wire service based on the connected load should be determined as follows: Total of all 230-volt circuits and ½ of all 115-volt circuits based on

(a) Full load current of largest motor x 1.25 (where two or more motors of equal size are concerned, apply this factor to one only).

(b) The full load current of all other large or permanently connected equipment.

(c) All convenience outlets at 1½ amperes per outlet.

(d) All lighting outlets at 1½ amperes per outlet (except for special lighting installations which should be figured on the actual connected load).

(e) The selection of the wire (see Appendix I, Table I-I).

(f) The size of neutral conductor (the maximum possible unbalanced 115-volt load current should be determined and the wire size selected from Appendix I, Table I-I). All straight 230-volt loads not connected to the neutral should be omitted.

(4) The wire size requirements based on the voltage drop should be determined from the load as computed in (3) above, the length of feeder and the desired voltage drop. The wire size should be obtained from Appendix I, Table I-II, and the neutral wire from Table I-III using the value of load current as determined in (3)(f) above.

**NOTE**

1 per cent voltage drop should be used on the maximum demand when it supplies poultry brooders, incubators, fluorescent lighting or other voltage sensitive applications. For other loads, 2 per cent voltage drop should be used.

**3.4.1.4 Feeders Between Buildings**—The size of feeders between buildings should be determined in the same manner as feeders from pole to buildings.

**3.4.2 Underground Services and Feeders**

(1) The size of conductors should be carefully planned so that future replacement due to inadequacy will be unlikely.

(2) Determination of wire sizes should follow the same basic steps as for overhead installations.

### 3.4.3 Service for the Individual Buildings (Other than Residence)

The method of selecting service-entrance conductors for the individual building should be based on the same requirements as the selection of feeders.

**3.4.3.1 Selecting the Service Entrance Conductors**—Once the present and probable future electrical needs of the building are determined, the required conductor sizes can be determined. The procedure should be the same as for feeders.

NOTE

In no case should the service-entrance wires be smaller than the wires in the feeder supplying the building under consideration.

**3.4.3.2 Selecting the Disconnecting Means**—Where a single switch or circuit breaker is used, its capacity in amperes should, in general, correspond to that of the service-entrance conductors, and it should be large enough to handle the starting current of the largest motor without blowing the main fuses or tripping the breaker.

NOTE

Before planning service-entrance equipment, the power supplier should be contacted for local regulations.

### 3.4.4 Emergency Service

(1) The generator should be properly grounded in accordance with the "Canadian Electrical Code", C22.1, published by the Canadian Standards Association.

(2) The local power supplier should be consulted before planning for a standby generator.

**3.4.5 Three-Phase Equipment on Single-Phase Service**—The power supplier should be consulted concerning the size of phase converter that can be operated in a particular location.

*"Phase Converter" means a device that will permit the operation of a three-phase induction motor from a single-phase power source.*

### 3.4.6 Isolated Motors

Motor-driven equipment, such as irrigation or drainage pumps, located at a considerable distance from the farm buildings should be served by a separate service drop or by a circuit from the farm service.

### 3.4.7 General Requirements for Lighting and Other Outlets

Recommendations in this subsection are based on the use of concentrated light sources, such as incandescent lamps. For linear light sources, the outlets should be located to suit the installation planned.

**3.4.7.1 Lighting Outlets for Particular Locations—**

(1) A certificate of inspection should be obtained where inspection service is available; otherwise an affidavit should be secured

**3.4.7.1** (1)

from the electrical contractor attesting to conformity with the applicable safety regulations.

(2) All lighting outlets should be wall-switch controlled unless otherwise stated.

(3) For wet and damp locations, lamp receptacles with non-metallic coverings should be used.

(4) Lighting fixtures in feed-grinding rooms, feed storages, hay mows and other dusty locations should be of the dust-proof type.

(5) At least two wall-switch controlled outlets should be provided for each stairway, unless the head and foot of the stairway are adequately lighted from other sources.

(6) One outlet should be provided for every 20 lineal feet of main passageways.

**3.4.7.2 Locations of Convenience Outlets**—Convenience outlets, where required, should be located as high as can be reached conveniently to avoid damage from stock. These outlets should be mounted between studding or flush with wall.

**3.4.7.3 Location of Wall-Switches**—Wall-switches should be mounted at a height of approximately 52 in. above the floor line, except in buildings where livestock are housed, where they should be located as high as can be reached conveniently to avoid damage by stock.

**3.4.7.4 Multiple-Switch Control**—All spaces for which wall-switch controls are required, and which have more than one entrance, should be equipped with a multiple-switch control at each principal entrance.

**3.4.7.5 Outlets—**

(1) Special circuits serving stationary equipment should terminate in a safety switch or outlet box, to which equipment can be connected.

(2) Convenience outlets should be used for portable equipment.

(3) Grounding receptacles designed to receive a 3-pronged plug should be used for buildings housing livestock, the farm workshop, damp locations such as basements, and structures having concrete floors.

**3.4.7.6 Motors (Including Ventilating Fans)—**

(1) Motors over ⅓ horsepower should be provided with a separate outlet.

(2) Motors over ½ horsepower should be on 230-volt circuits.

(3) Motors under ⅓ horsepower may be connected to convenience outlet circuits if provided with individual motor over-load protection.

(4) If motors are connected to the lighting circuit, the connections should be made ahead of the lighting switch.

### 3.4.8 Branch Circuits

*"Branch Circuit (General Use)" means that portion of the wiring system extending from the final fuse or circuit-breaker to the outlets for general use, such as lighting and convenience outlets.*

*"Branch Circuit (Individual Equipment)" means a circuit installed to supply a single motor or appliance. (In general, any stationary appliance of 1000 watts or over, of ½ hp or over, should be wired on such a circuit.)*

**3.4.8.1 Design—**

(1) Special circuits serving poultry brooders, incubators and any other heating equipment on which life processes depend should be designed for 1 per cent voltage drop.

(2) Other special circuits should be designed in accordance with clause 3.4.1.3.

**3.4.8.2 15-Ampere Circuits—**

(1) No. 12 AWG copper wire should be the minimum size for branch circuits.

(2) 15-ampere branch circuits may be used to serve

(a) permanently connected lighting equipment,

(b) convenience outlets for portable trouble lamps, drills, clippers, ¼ and ⅓ hp. portable motors and miscellaneous appliances not in continuous service, and

(c) special lighting equipment with switch control, such as ultraviolet or bactericidal lamps, which is particularly sensitive to voltage drop.

**3.4.8.3 Protection—**

(1) Each branch circuit should be protected by its own fuses or circuit breakers.

(2) Where a motor is the principal load, it should have its own special protection.

(3) Where motor-starting currents are involved, time-delay fuses or circuit breakers having suitable operating characteristics should be used.

### 3.4.9 Dairy Structures

**3.4.9.1 Tie Stall Dairy Barns—**

(1) *Lighting Outlets*

(a) Litter alleys should be provided with one lighting outlet for every 2 or 3 stalls and be located on the center line of the alley.

(b) One lighting outlet should be provided every 10 to 15 ft. on center line of feed alleys.

(c) One ceiling outlet should be provided for each bull, maternity or calf pen (100 sq. ft. or larger). Individual wall-switch control should be provided outside the pen.

**3.4.9.1**

(2) *Convenience Outlets*

(a) Convenience outlets should be installed at least every 20 ft. along litter alleys.

(b) One outlet should be provided out of reach of the animals for each maternity pen installed. Where pens have low partitions, one outlet may be located to serve two pens.

(3) *Special Purpose Outlets and Circuits*

(a) A 230-volt circuit using a minimum of No. 12 A.W.G. wire should be provided for pipeline milkers.

(b) The circuits provided for gutter cleaners should be 230 volts. The circuit wire size should be based on the motor horsepower.

(c) Ventilating Fans: See clause 3.4.7.6.

**3.4.9.2 Loose Housing Dairy Barns—**

(1) *Lighting Outlets*

One lighting outlet should be provided for every 400 sq. ft. of open pen area.

(2) *Convenience Outlets*

(a) One outlet should be provided at each location where equipment such as clippers, groomers, immersion heaters, etc., can be used conveniently.

(b) One outlet out of reach of animals should be provided for each maternity pen.

(3) *Special-Purpose Outlets*

(a) Where water systems need protection against freezing, provision should be made for heating cable or other heating devices.

(b) Separate outlets should be provided for equipment for bunk feeders.

**3.4.9.3 Milking Parlor (with Cows in Tie Stalls)—**

(1) *Lighting Outlets*

(a) One outlet should be provided for every 3 cows, on centre line of passage in front of the cows.

(b) One outlet should be provided for every 2 cows, on centre line of passage in back of the cows.

(2) *Convenience Outlets*

One outlet should be provided for every 4 or 5 cows.

(3) *Special-Purpose Outlets*

(a) One 230-volt outlet should be provided for the milking machine.

(b) Ventilating Fans: See clause 3.4.7.6.

**3.4.9.4 Milking Parlor (with Cows in Tandem Stalls on One or Both Sides of Milking Pit)—**

(1) *Lighting Outlets*

(a) One outlet should be provided over the milking pit opposite the rear of each cow on the centre line of pit.

(b) To provide more concentrated light on the cow's udder, a flush, built-in floor-type unit should be used.

(c) One outlet should be provided at each entrance and exit of cow passageways.

(2) *Convenience Outlets*

One outlet for every 2 cows should be provided on either side of the pit.

(3) *Special-Purpose Outlets*

(a) A 230-volt outlet should be provided for the milking machine, unless a portable milker is used.

(b) Ventilating Fans: See clause 3.4.7.6.

(c) When a heater is used in a milking parlour a 230-volt outlet should be provided.

**3.4.9.5 Milkhouses or Milkrooms (Can Cooler)—**

(1) *Lighting Outlets*

(a) One outlet should be provided for every 100 sq. ft. of floor area.

(b) From the total number of outlets determined in (a), one outlet should be placed in the centre of the ceiling and one or two outlets over each work area. (See clause 4.1.1.1(3)(g)(ii)).

(c) A minimum of 2 watts per sq. ft. floor area should be provided.

(d) A 150-watt lamp in a suitable diffusing glass unit should be used over utensil and bottlewashing and sterilizing areas.

(e) One exterior outlet should be provided for illuminating loading platforms and driveways.

**3.4.9.6 Milkhouses or Milkrooms (Bulk Tank)—**

(1) *Lighting Outlets*
See clause 3.4.9.5.

(2) *Convenience Outlets*

(a) One outlet should be provided for each work area.

(b) The outlets should be placed at least 57 in. above floor.

(3) *Special Purpose Outlets*

230-volt individual circuits should be provided for
Water Heaters (if electrical)

**3.4.9.6** (3)

Milkroom Heaters (if electrical)
Coolers
Vacuum Pumps (Milker)
Tank Truck Pump Outlets (to be located on the outside wall near the hose port; to be controlled by a switch on the inside near the bulk tank outlet; and to conform to the bulk tank truck outlet).

(4) *Electric Heating (if used)*

(a) One "fan type" permanently installed heater with thermostat control should be provided.

(b) Separate radiant heater or heat lamps may be installed over wash-up area for operator comfort.

(5) *Ventilating Fans*

See clause 3.4.7.6.

### 3.4.10 Poultry Structures

#### 3.4.10.1 Laying Houses—

(1) *Morning Lighting*

(a) One outlet should be provided for every 200 sq. ft. of floor area.

(b) In a house or pen 20 ft. deep, one row of lighting outlets 10 ft. apart should be installed along a line midway between the front of the house and the dropping board.

(c) The outlet at the end of the row in (b) should be 5 ft. from the end of the pen.

(d) The lighting-unit outlets should be mounted at the ceiling, equipped with 60-watt lamps and widespread reflectors.

(e) Pens deeper than 20 ft. should have one of the following installations

(i) In houses 30 ft. deep or deeper with roost in centre of pen, outlets should be placed in rows not more than 10 ft. on centre.

(ii) With roosts at back of pen, an outlet should be provided for each 200 sq. ft. of pen area with outlets in two rows, staggered with respect to each other.

(f) Time-switch control should be provided for lighting outlets.

(g) In multi-storey or large poultry houses, where the number of lighting outlets is in excess of the number which can be installed on a single branch circuit, a heavy-duty feeder should be run, through the time switch, to the different floors or pens with local circuit protection and switch control at each floor or pen.

**3.4.10.1**

(2) *Morning and Evening Lighting*

(a) Bright-light outlets should be installed in the same manner as for morning lighting.

(b) Dim-light outlets of 10 watts each should be installed on a separate circuit, one outlet for every 400 sq. ft. of floor area and placed in a row slightly back of bright-light outlets towards roosts.

(c) Time-switch control should be provided for lighting outlets.

(3) *Special-Purpose Outlets*

Outlets should be provided for special equipment as required.

**3.4.10.2 Brooder Houses (Portable or Colony Type)—**

(1) *Lighting Outlets*

One outlet should be provided on the ceiling or wall near the door.

(2) *Special-Purpose Outlets*

(a) One outlet should be provided on the ceiling in the centre of the space to serve the brooder and water warmer.

(b) 1000 watts should be allowed for the hover-type brooder or the four-lamp infrared brooder.

**3.4.10.3 Brooder Houses (Permanent Type)—**

(1) *Lighting Outlets*

(a) One outlet should be provided for each brooder pen.

(b) If brooders are to be used in a combination laying and brooder house, the recommendations for lighting outlets given in clause 3.4.10.1 should be followed.

(2) *Special-Purpose Outlets*

(a) One outlet should be provided in each pen in the ceiling over the brooder with 1000-watt capacity for the hover-type brooder or four lamp infrared brooder.

(b) In large installations containing a number of brooder units, special circuits or outlets should be provided.

**3.4.10.4 Battery Brooders, Incubators and Hatchers**—This equipment requires special individual consideration. Each battery brooder, incubator or hatcher should have individual overcurrent protection.

**3.4.10.5 Egg-Storage and Handling Rooms—**

(1) *Lighting Outlets*

(a) One outlet should be provided for every 200 sq. ft. of floor area.

(b) Two outlets should be provided over each work area if incandescent lighting units are used or one outlet if fluorescent units are used.

**3.4.10.5**

(2) *Special Purpose Outlets*

An individual 230-volt circuit should be provided as required.

**3.4.10.6 Poultry Cleaning and Dressing Rooms**—

(1) *Lighting Outlets*

(a) One outlet should be provided for every 200 sq. ft. of floor area.

(b) Two outlets should be provided over each work area if incandescent lighting units are used, or one outlet if fluorescent units are used.

(2) *Convenience Outlets*

One outlet should be provided for every 400 sq. ft. of floor area.

(3) *Special-Purpose Outlets*

(a) 230-volt circuits should be provided as required for the following equipment

Poultry Scalders
Waxers
Wax Reclaimers
Picking Machines
Conveyors
Refrigeration Equipment
Water Heaters (if electrical)

(b) Ventilating Fans: See clause 3.4.7.6.

**3.4.11 Beef Cattle Structures**

**3.4.11.1 Beef Barns**—

(1) *Lighting Outlets*

(a) One outlet should be provided for every 150 sq. ft. of open pen area.

(b) One outlet should be provided every 15 ft. in the feed alley.

(2) *Special Purpose Outlets*

(a) An outlet should be provided if required for bunk feeders using weatherproof electrical equipment if outdoors.

(b) To protect water supply against freezing an outlet should be provided, if required, for a heating cable or heating device.

**3.4.12 Horse Structures**

**3.4.12.1 Horse Stables (Tie Stalls)**—

(1) *Lighting Outlets*

(a) One outlet should be provided at the rear of every other tie stall on centre line of alley.

(b) One outlet should be provided for every 15 ft. on centre line of the feed alley.

**3.4.12.1** (1)

(c) One outlet should be provided for both a feed room and box stall.

(2) *Convenience Outlets*

(a) One outlet should be provided at rear of every other tie stall.

(b) In barns having a centre litter alley, one outlet will serve 2 to 4 stalls depending upon the structure.

(c) One outlet should be provided near the entrance to box stalls.

(d) Ventilating Fans: See clause 3.4.7.6.

(e) An outlet should be provided in both the harness room and feed room.

**3.4.12.2 Horse Stables (Box Stalls)—**

(1) *Lighting Outlets*

(a) One outlet should be provided every 15 ft. on centre line of feed alleys.

(b) One outlet should be provided for each box stall.

(c) One outlet should be provided for both the harness room and feed room.

(2) *Convenience Outlets*

(a) Outlets should be provided in the feed alley so that one serves each four stalls.

(b) Ventilating Fans: See clause 3.4.7.6.

(c) One outlet should be provided for both the harness room and feed room.

(3) *Special-Purpose Outlets*

A separate outlet should be provided if required for an oat crusher or roller mill in feed room.

**3.4.13 Sheep Structures**

**3.4.13.1 Sheep Barns and Lambing Sheds—**

(1) *Lighting Outlets*

One outlet should be provided for every 15 ft. on centre line of feed alley.

(2) *Convenience Outlets*

(a) One outlet should be provided for each pair of pens.

(b) An outlet for sheep shearers should be provided on the wall or post at the location where shearing is done.

(c) Ventilating Fans: See clause 3.4.7.6.

(3) *Special-Purpose Outlets*

To protect water supplies against freezing, an outlet should be provided if required for the use of heating cable or heating device.

### 3.4.14 Hog Structures

#### 3.4.14.1 Hog and Farrowing Houses—

(1) *Lighting Outlets*

One outlet located over the partition line should be provided for each pair of hog pens or for every 200 sq. ft.

(2) *Convenience Outlets*

(a) One outlet should be provided for each farrowing pen.

(b) Ventilating Fans: See Section 3.4.7.6.

(3) *Special-Purpose Outlets*

(a) To protect the water supply against freezing, an outlet should be provided if required for a heating cable or heating device.

(b) An outlet should be provided for a feed cooker if required.

(4) *Under-Floor Cable Heating*

The local power supply authority should be consulted for regulations covering under-floor cable heating.

### 3.4.15 Field Crop Structures

#### 3.4.15.1 Feed-Grinding Rooms—

(1) *Lighting Outlets*

(a) One outlet should be provided for every 150 sq. ft. of floor area.

(b) Outlets should be provided over work areas where required.

(c) Fixtures should be dust-proof, the switch should also be dust-proof unless mounted outside of the room.

(2) *Special-Purpose Outlets (230 volts)*

Outlets should be provided for feed grinders and for feed mixers.

#### 3.4.15.2 Feed-Storage Room—

(1) *Lighting Outlets*

(a) One outlet should be provided for every 400 sq. ft. of floor area.

(b) Dust-proof fixtures should be used, the switch should also be dust-proof unless mounted outside the room.

(2) *Special-Purpose Outlets*

A 230-volt outlet should be provided for grain dryers.

#### 3.4.15.3 Mow Areas—

(1) *Lighting Outlets*

(a) One outlet should be provided for every 1,000 sq. ft. of floor area.

**3.4.15.3** (1)

(b) Fixtures should be dust-proof.

(c) Outlets should be located so that hay chutes and ladders are lighted and that fixtures are readily accessible for cleaning a lamp replacement even when mow is empty.

(2) *Convenience Outlets*

One outlet for connecting portable 115-volt equipment should be provided for every 500 sq. ft. of floor area.

(3) *Special-Purpose Outlets*

230-volt outlets should be provided as required for the following equipment

Hay Hoists
Hay Dryers
Portable Elevators

**3.4.15.4 Corn Cribs or Granaries—**

(1) *Lighting Outlets*

(a) One outlet should be provided for every 300 sq. ft. of floor area.

(b) Dust-proof fixtures should be used.

(2) *Special-Purpose Outlets*

230-volt outlets should be provided for corn or grain dryers and for elevators as required.

**3.4.15.5 Silos—**

(1) *Lighting Outlets*

(a) Two outlets should be provided—one on the ceiling of the silo and the other at the top of the chute, wall-switch controlled at foot of the chute or at the entrance to the tunnel leading to the chute.

(b) Outlets should be placed so that they can be reached from the top of the chute ladder for cleaning and lamp replacement.

(2) *Convenience Outlets*

Outlets should be provided, if required, for self-unloading wagons.

(3) *Special-Purpose Outlets*

A 230-volt outlet should be provided for a silo unloader.

**3.4.15.6 Tobacco Stripping Rooms—**

(1) *Lighting Outlets*

Outlets should be located over the front edge of stripping benches. The spacing of outlets will depend upon the height and type of fixture.

**3.4.15.7 Tobacco Barns (Burley)—**

(1) *Lighting Outlets*

Outlets should be provided every 12 ft. on posts on the side of the driveway.

**3.4.16 Fruit and Vegetable Crop Structures**

**3.4.16.1 Fruit and Vegetable Storage—**

(1) *Lighting Outlets*

(a) One outlet should be provided for every 300 sq. ft. of floor area, except in bulk potato storage, where one outlet should be provided for every 1,000 sq. ft.

(b) An outlet should be provided for each machine, such as washers, graders, conveyors, etc., with local wall-switch control for each outlet or group of outlets.

(2) *Convenience Outlets*

One outlet should be provided for every 400 sq. ft. of floor area for use of supplementary lighting or equipment.

(3) *Special-Purpose Outlets*

Outlets and circuits should be provided for refrigeration and other equipment over ⅓ hp.

**3.4.16.2 Greenhouses—**

(1) *Lighting Outlets*

(a) One outlet should be provided for every 15 ft. through the centre of the house.

(b) One outlet should be provided over each work bench in the head house with a minimum of one outlet for every 10 ft. of work bench.

(c) Boiler rooms should be provided with one or more lighting outlets.

(2) *Special-Purpose Outlets*

(a) Outlets for soil heating, pasteurization, and sterilization should be provided where required.

(b) Outlets should be provided for portable spray pumps.

**3.4.17 Farm Workshops and Machinery Sheds**

**3.4.17.1 Farm Workshops—**

(1) *Lighting Outlets*

(a) One outlet should be provided for every 200 sq. ft. of floor area.

(b) One outlet should be provided for each permanently placed piece of equipment or at least one outlet for each 10 ft. of bench length.

**3.4.17.1**

(2) *Convenience Outlets*

(a) One outlet should be provided for each 5 ft. of bench length.

(b) One outlet should be provided for each permanently placed piece of equipment.

(3) *Special-Purpose Outlets*

Local power supply authorities should be consulted for the installation of electric welders.

**3.4.17.2 Machinery Sheds—**

(1) *Lighting Outlets*

One outlet should be provided for every 1,000 sq. ft. of floor area.

(2) *Convenience Outlets*

(a) One outlet should be provided for every 800 sq. ft. of floor area.

(b) A 115-volt duplex outlet should be provided per vehicle on separate circuit.

**3.4.18 Water Supply**

**3.4.18.1 Water Supply (with Pump in Farm Building)—**

(1) *Special-Purpose Outlets*

(a) An outlet on a separate circuit should be provided, away from fire hazards, for each water pump.

(b) Outlets for the pump should be equipped with a disconnect switch for use when servicing the pump.

(c) If the pump motor is not equipped with a thermal overload device, motor overload protection should be supplied in the circuit.

(d) Where two or more pumps are located adjacent to one another, they may be supplied on one special feeder, terminating in separate motor disconnecting switches equipped with branch-circuit protection as well as with motor-running overcurrent protection.

**3.4.18.2 Water Supply (with Pump in Separate House)—**

(1) *General*

The pump-motor circuit should be on a separate disconnect from the remainder of the farm wiring.

(2) *Lighting Outlet*

One outlet should be provided.

(3) *Convenience Outlet*

One outlet should be provided.

**3.4.18.2**

(4) *Special Outlet*

One outlet should be provided for a heater if required.

(5) *Grounding*

(a) The water pump should be properly grounded.

(b) When plastic pipe is used a separate ground must be installed.

### 3.4.19 Exterior Lighting

#### 3.4.19.1 Lighting Outlets—

At least one yard light and lights on front, back or sides of livestock building should be provided.

#### 3.4.19.2 Branch Circuit—

(1) Yard lights should be on a separate circuit.

(2) Multiple-switch control from two or more points with 3-way and 4-way switches should be provided.

## 3.5 WATER SUPPLY

This Section applies to the provision of water supply for farm buildings.

### 3.5.1 Source

#### 3.5.1.1 General

(1) Source of water may be from a municipal water supply system, a deep well, a shallow well or spring provided that the source provides water of satisfactory quality as determined by the local health authorities. Where water is obtained from surface sources, adequate facilities for treatment should be provided and treated water should be tested at regular intervals.

(2) Adequate precautions should be taken to avoid contamination.

#### 3.5.1.2 Wells—

(1) Wells should be located at an elevation that is safe from pollution.

(2) Drilled wells should be provided with a casing of watertight material effectively sealed against pollution.
(See Appendix J, Figure 1J).

(3) Dug wells should be

(a) provided with a tight-fitting impervious cover,

(b) provided with a watertight casing extending at least 10 ft. in depth and 6 in. above grade, and

(c) located and so graded as to divert surface water (see Appendix J, Figure 2J).

**3.5.1.3 Springs—**

(1) Springs may be used as a source of water but special precautions should be taken to avoid contamination (see Appendix J, Figure 3J).

(2) All springs should be fenced to exclude livestock.

(3) All springs should be protected by diversion ditches.

(4) All springs should be protected by a concrete spring box that is well flushed and disinfected before water is delivered to the supply lines.

**3.5.1.4 Surface Sources—**

(1) Surface water sources (lake, stream or pond) should be avoided or preferably used only for stock watering.

(2) Where water from a surface source must be used for household purposes, special treatment is essential. Local health authorities should be consulted.

**3.5.2 Installation of Water Supply and Distribution Systems**

**3.5.2.1 General**

(1) The water supply and distribution system should be installed in accordance with Part 7 of the "National Building Code of Canada" and Supplement No. 4 "Handbook of Plumbing Sketches."

(2) All materials used in water supply systems should be of good quality and should comply with the specifications in Part 7 of the "National Building Code of Canada".

(3) Pumps and other devices should be installed in such a manner to provide protection against contamination and to ensure efficient operation. (See Appendix J, Figures 4J, 5J, 6J and 7J).

(4) When pumps are located in separate structures or normally unheated areas, the pump enclosures should be insulated, and if required, heat should be provided.

**3.5.2.2 Shallow Well Pumps**—Shallow well pumps should not be installed more than 22 ft. above the anticipated water level at time of maximum draw down.

**3.5.2.3 Deep Well Pumps**—Where deep well jet pumps are offset from the well, special precautions should be taken to prevent contamination at the junction of the casing and supply pipes.

**3.5.2.4 Submersible Pumps**—Where submersible pumps are used, sanitary caps should be provided and special precautions should be taken to prevent contamination at the junction of the casing and supply pipes.

**3.5.3 Water Quantities**

**3.5.3.1 Water Consumption—**

(1) For optimum water consumption by livestock the water should be available at a temperature of 50° F. and in quantities given in Table XXI.

**3.5.3.1** (1)

**TABLE XXI**

**Daily Water Requirements of Livestock**

| Class of Livestock | Daily Water Requirements (gals.) |
|---|---|
| Milk Cow | 30 |
| Beef or Dry Cow | 12 |
| Horse | 12 |
| Hog | 1.5 |
| Sheep | 2 |
| 100 Chickens | 6 |
| 100 Turkeys | 10 |

(2) Watering facilities in loose housing and other unheated structures should be protected against freezing by the use of CSA approved frost-proof water bowls or heated tanks.

**3.5.3.2 Water for Cleaning Purposes—**

(1) *Cold Water for Cleaning Purposes*

Water should be available at the rate of 200 gal. per hr. and a minimum pressure of 30 lb. per sq. in. for washing floors of milking parlours, milk rooms, livestock pens, and poultry houses.

(2) *Hot Water and Steam for Cleaning Purposes*

(a) General:

(i) All water heating equipment should carry the approval of the Canadian Underwriters' Laboratories or the Canadian Standards Association.

(ii) All water heating equipment should be installed in accordance with the manufacturer's recommendations.

(iii) All water heating equipment should be equipped with combination temperature-pressure relief valves. Steam boilers should also be equipped with low water cut-off safety relief valves.

(iv) Plastic pipe should not be used for hot water applications.

(b) Dairy Farms:

(i) Milk rooms should have available hot water at a temperature of 160° F. Heaters should be equipped with a reliable thermometer installed in the delivery line.

(ii) Water heaters installed in milk rooms should have sufficient storage capacity combined with a recovery rate sufficient to supply 1 gallon of 160° F. water for each milking cow per milking.

**3.5.3.2** (2) (b)

(iii) Where a pipe line milker is used, a water heater that will supply 1 gallon of 160 °F. water per milking cow plus an allowance of 50 gallons for pipeline washing, should be provided.

(iv) Milking parlours should be supplied with a hot water outlet, equipped with a mixing valve, to deliver water at the proper temperature for washing cattle.

(v) Water heater requirements should be based on herd size (See Appendix J, Table J-1).

(c) Poultry Farms:

(i) Hot water should be provided for cleaning equipment in service rooms of poultry houses.

(ii) Where on-the-farm egg washing is carried out, hot water should be available to supply the requirements of the washer used.

(d) Other Uses: Hot water and steam should be available in abattoirs and killing plants.

### 3.5.3.3 Water for Fire Protection

(1) Water from any adequate source may be used for fire protection.

(2) Farm ponds constructed to store water for fire protection should be readily accessible and located at a distance not greater than 500 ft. from the farmstead.

(3) Pumps used to supply water for fire protection should have a minimum capacity of 300 gal. per hr. at 30-psi pressure.

(4) Where the pump used to supply water for fire fighting is electrically operated, it should be supplied by a line that is independent of all buildings, see clause 3.4.18.2.

## 3.5.4 Design of Water Distribution Systems

### 3.5.4.1 General—

(1) Pipes used to carry water between buildings should be of corrosion-resistant material.

(2) All permanent supply pipes should be laid below frost level.

(3) All distribution pipes should be designed to allow a minimum flow of 10 gallons per minute.

(4) Individual branches to single outlets should be designed to allow a minimum flow of 5 gallons per minute.

(5) Main lines from pumps should be designed to carry a minimum flow equal to pump capacity.

(6) The pressure drop between the pump and the most remote fawcett should not be more than 5 lb./sq. in.

**3.5.4.2 Pipe Sizes**—Pipe sizes should be determined on the basis of flow requirements and maximum allowable pressure drop. (See Appendix J, Table J-II).

## 3.6 WASTE DISPOSAL

### 3.6.1 General

All wastes on farms should be disposed of in a safe and sanitary manner. Wastes should not be allowed to drain away, either by surface or sub-surface drains, into any runway, watercourse, open ditch, stream or river but should be disposed of in such a manner that no possible pollution can occur.

### 3.6.2 Manure Storage

(1) Manure storage facilities should be designed to receive the following quantities daily:

| | |
|---|---|
| For each Dairy or Beef Cow | 3 cu.ft./day includes bedding |
| For each Horse | 3 cu.ft./day includes bedding |
| For each Hog | ½ cu.ft./day includes bedding |
| For each Hog | ¼ cu.ft./day no bedding |
| For each Sheep | ¼ cu.ft./day |
| For each 100 Chickens | ½ cu.ft./day |

(2) Minimum manure storage capacity should be not less than that required to receive one week's production.

### 3.6.3 Waste Disposal on Dairy Farms

#### 3.6.3.1 Manure Storage—

(1) Manure in solid form should be stored in a manure storage shed with a concrete floor specially designed to trap liquid wastes.

(2) Where manure is stored in liquid form, a tank should be provided.

(3) Where a lagoon is used for manure disposal it should be designed as specified in subsection 3.6.5.

#### 3.6.3.2 Disposal of Wastes—

(1) Where liquid manure storage is available the following procedures should be followed

(a) All washings of manure from milking parlour floors should be delivered to a properly designed septic tank, or liquid manure tank.

(b) All wash waters from milk rooms, milkhouses and milking parlours should be delivered to a liquid manure tank.

(2) Where liquid manure storage is not available the following procedures should be followed

(a) All solid manure should be removed and placed in the manure storage.

(b) Floor wash water from milking parlours and any domestic sewage should be piped to a septic tank having a minimum capacity of 500 gallons.

**3.6.3.2** (2)

(c) Overflow from septic tanks should be carried to a properly designed disposal system.

(d) Milk wastes should not be placed in septic tanks receiving domestic sewage.

(e) Milk wastes should be disposed of by a separate disposal system or may be discharged directly to an underground disposal bed having not less than 2 lineal feet of 4-in. tile per cow in the herd.

### 3.6.4 Waste Disposal on Poultry Farms

**3.6.4.1 Manure**—All manure should be handled and disposed of in the same manner as provided in clause 3.6.3.1.

**3.6.4.2 Dead Birds**

(1) *Disposal Pits*

(a) Pits used for dead bird disposal should be based on flock size

For Broilers—20 cu. ft. per 1000 birds in flock

For Layers—100 cu. ft. per 1000 birds in flock

(b) Disposal pits should be located not less than 150 ft. from any well or spring used as a water supply (see Appendix K. Figure 1K).

(c) Disposal pit retaining walls should be made of wood, metal or concrete and so constructed as to be rodent and insect proof.

(d) Pits should be covered with tight-fitting, rodent and insect proof covers having drop openings equipped with tight-fitting lids.

(e) Abandoned wells or springs should not be used as disposal pits.

(2) *Incinerators*

(a) Incinerators, when used for the disposal of dead birds, should be designed to consume all material. (SS Appendix K, Figure 2K).

(b) Fuels used for incinerators may be natural or bottled gas or fuel oil.

(c) Incinerators should be firesafe and located at least 50 ft. from any building.

(d) Incinerators should be located so that prevailing winds carry odors away from dwellings.

### 3.6.5 Manure Lagoons

*"Manure Lagoon" means a structure specifically designed to treat liquid organic wastes by biological, chemical and physical processes commonly referred to as natural self-purification.*

**3.6.5.1 Location**—A lagoon should be located

(1) with adequate area for expansion;

(2) on the leeward side of the house;

(3) a distance of at least 500 ft. from any living area;

(4) to exclude surface drainage from adjacent areas;

(5) where it is not possible to contaminate surface and well water supplies;

(6) where trees or buildings will not hinder wind or wave action.

**3.6.5.2 Area and Loading**—

(1) The local Health and/or Water Authority should be consulted before lagoon location and size is determined.

(2) Allowable loading rates for lagoons used for manure disposal depend upon the following factors

(a) Climatic data including precipitation-evaporation ratio.

(b) Proximity to populated areas and water supplies.

(c) Effect of effluent on streams.

(d) Local regulations.

(3) Aerobic Lagoons

*"Aerobic Lagoon" means a lagoon in which the treatment of waste material is achieved in the presence of oxygen.*

(a) Where odor-free operation is required, the lagoon should be designed for aerobic operation resulting in complete oxidation.

(b) Local Authorities should be consulted for allowable loading rates for the disposal of domestic sewage per acre of lagoon. Table XXII should be used to convert these rates to agricultural use.

**TABLE XXII**
**Loading Rates Per Acre of Lagoon**

| Population Equivalent | | Population Serviced Per Acre of Lagoon Surface Area for Load Factors 100 to 300 | | | | |
|---|---|---|---|---|---|---|
| Man | 1 | 100 | 150 | 200 | 250 | 300 |
| Horses | 11.3 | 9 | 13 | 18 | 22 | 26 |
| Cows | 16.4 | 6 | 9 | 12 | 15 | 18 |
| Sheep | 2.45 | 41 | 60 | 80 | 100 | 120 |
| Hogs | 1.9 | 52 | 80 | 100 | 130 | 160 |
| Chickens | 0.014 | 7000 | 10,500 | 14,000 | 17,500 | 21,000 |

(c) Due to relatively large area and water requirements, aerobic lagoons should be used for livestock manure disposal only where adequate distance separation from human dwellings cannot be obtained.

(4) Anaerobic Lagoons

*"Anaerobic Lagoon" means a lagoon in which the treatment of waste material is achieved in the absence of oxygen.*

(a) Where lagoons can be located with adequate distance separation (1000 feet) from human dwellings, an anaerobic lagoon may be used for manure disposal.

(b) Surface area required for anaerobic lagoons should be as given in Table XXIII.

**TABLE XXIII**
**Surface Area for Anaerobic Operation**

| Total Excreta, no bedding | Surface Area | Animals per Acre |
|---|---|---|
| Per Hog | 40 sq. ft. | 1,100 |
| Per Sheep | 50 sq. ft. | 870 |
| Per Horse | 300 sq. ft. | 145 |
| Per Cow | 350 sq. ft. | 125 |
| Per Chicken | 1 sq. ft. | 43,560 |
| Milking & Milkroom Wastes per Cow | 50 sq. ft. | 870 |

**NOTE**

The figures in Table XXIII may be reduced to ¼ if odor can be tolerated. They can be reduced to ½ if occasional odor can be tolerated. These lagoons are essentially open cesspools.

(5) Combined Anaerobic and Aerobic Lagoons

(a) Where effluent from lagoons may reach streams, the discharge from anaerobic lagoons may produce biochemical oxygen demand loadings that prohibit their use. By providing secondary treatment in a lagoon designed for aerobic operation, the biochemical oxygen demand may be reduced in the final effluent.

(b) Combined anaerobic and aerobic lagoons should consist of two cells of equal area operating in series.

(c) All fresh manure should be deposited in the anaerobic cell. Overflow to the second cell (aerobic cell) should be controlled by a structure as shown in Appendix K, Figure 6K.

(d) Water depth in anaerobic cells should be based on construction costs but should not be less than 4 ft.

(e) Water depth in aerobic cells should be not greater than 3 ft. 6 in. during the operating season (all times when lagoon is ice-free and temperatures are above 32° F.)

(f) Surface areas for combined anaerobic-aerobic lagoons should be as given in Table XXIV.

**TABLE XXIV**
**Surface Area for Combined Anaerobic-Aerobic Operation**

| Class of Livestock | Req'd. Area of Anaerobic Lagoon (sq. ft. per animal) | Req'd. Area of Aerobic Lagoon (sq. ft. per animal) | Animals per Acre of total Lagoon Area |
|---|---|---|---|
| Horses | 225 | 225 | 100 |
| Cows | 260 | 260 | 85 |
| Sheep | 40 | 40 | 550 |
| Hogs | 30 | 30 | 720 |
| Chickens | .75 | .75 | 30,000 |

**3.6.5.3 Shape**—Lagoon shape should be essentially square or rectangular, with inside circular corners. Coves, peninsulas or islands should be avoided.

**3.6.5.4 Depth**—The operating depth of lagoon should be capable of being varied from 3½ ft. to 5 ft. in order to allow the water level to be raised to 5 ft. during winter months.

**3.6.5.5 Inlets**—

(1) Wastes may be placed in the lagoon

(a) directly from the feeding floor. (See Appendix K, Figure 5K);

(b) by means of a suspended pipe. (See Appendix K, Figure 3K); or

(c) by a submerged pipe on the lagoon bottom. (See Appendix K, Figure 4K).

(2) The inlet discharge area for centre loading should be covered with a circular concrete bed at least 3 ft. in diameter. (See Appendix K, Figure 4K).

**3.6.5.6 Outlets**—In cold climate the outlet structure should be placed so that ice coverage will not damage the structure. The outlet should be constructed so that the depth can be changed when necessary. (See Appendix K, Figue 6K and 7K).

**3.6.5.7 Dikes**—

(1) Good soil compaction should be maintained during construction

(2) Slopes

(a) Outside slopes should be 2 ft. horizontal to 1 ft. vertical.

(b) Inside slopes should range from 3 ft. to 4 ft. horizontal to 1 ft. vertical.

(3) Dike surface should be at an elevation of 2 ft. above the maximum liquid elevation.

(4) The dikes should be seeded with short-stemmed, shallow-rooted grass.

**3.6.5.8 Bottom of Lagoon**—The bottom of the lagoon should be essentially level. Vegetation should be removed prior to construction.

**3.6.5.9 Miscellaneous**—

(1) Lagoons should be enclosed by stock-tight fences.

(2) Signs should be attached to the fencing to indicate the purposes of the lagoon and give warning of any danger involved.

(3) Maintenance should be provided by the owner. Attention should be given to dike erosion, vegetation growth on dike, insect propagation and burrowing animals.

# PART IV HEALTH AND SANITATION

This Part states the building requirements which will permit the maintenance of structures in a condition conducive to the good health of animals and suitable for sanitary production of agricultural products.

## 4.1 HEALTH OF ANIMALS AND SANITATION REGULATIONS

### 4.1.1 Milk Production and Manufacture of Milk Products

#### 4.1.1.1 Fluid Milk Production—

(1) *General*

Dairy barns, milking parlors or other buildings or parts thereof in which milk is produced or handled should

(a) be situated, constructed and segregated in a manner to prevent any contamination of the product, and

(b) have their surroundings well drained.

(2) *Dairy Barns*

(a) Floors, Gutters and Mangers:

(i) The floors, gutters and mangers should be of concrete or other similar material.

(ii) The floors and floor gutters should be water-tight.

(iii) When the concrete in cattle stalls is to be covered, lumber of good quality, tongued-and-grooved, or equivalent material should be used.

(b) Dimensions:

(i) When a dairy barn has a double row of stalls facing the cattle inward to a centre alley, there should be a space of not less than 3 ft. 6 in. between the mangers, and a distance between each floor gutter and the walls not less than 6 ft.

(ii) Where a dairy barn has a double row of stalls facing the cattle to the outside walls, the space between floor gutters should be not less than 8 ft.

(iii) The floor gutters should have a minimum width of 16 in. and a minimum depth of 6 in.

(iv) Litter alleys and feed alleys should have no obstructions below 6 ft. 6 in. from the floor.

(c) Every dairy barn having an overhead storage space should be provided with a dust-proof ceiling.

(d) The interior walls and ceilings of rooms in which cows are milked should have finished surfaces which will provide conditions for the maintenance of good sanitation. Interior window sills should be flush with the window frame or sloped downward.

(e) The milking parlour should be separated from an attached loose housing area by a full partition broken only by doors which are self-closing.

**4.1.1.1** (2)

(f) A building housing dairy cattle should have no accommodation for animals other than cattle.

(g) A feed room should be provided for the storage of grain and mill feeds.

(h) All dairy barns should be constructed to provide adequate ventilation and lighting for the number of animals housed therein. See Section 3.2 and subsection 3.4.9.

(3) *Milkhouses*

(a) Location:

(i) A milkhouse should not be part of a dwelling or any other building other than a dairy structure.

(ii) Where a milkhouse is directly attached to a dairy barn, a vapour-proof wall should be provided between the two structures.

(iii) Where the entrance to the milkhouse from the barn is by a vestibule, the openings should be fitted with self-closing doors.

(iv) Where the milkhouse is separated from the structure in which cows are milked, this space should be at least 4 ft. wide.

(v) When a milking parlor is an integral part of a milkhouse, the milking parlor should be separated from the milkhouse by a partition containing a self-closing door.

(b) Milkhouses should be designed to accommodate screen doors and screen windows, or other suitable appliances which will effectively keep flies or other insects and vermin from entering the structures. Interior window sills should be flush with the window frame or sloped downward.

(c) In milkhouses and milking parlors, the floors and walls, for at least 12 in. in height, should be of concrete or equivalent material, finished with a smooth surface throughout. In addition, the walls above this height should be clad with some material which presents a hard, smooth surface and which is relatively impervious to moisture. The walls and ceiling should be well insulated to prevent the formation of condensation, and possible freezing conditions during cold weather.

(d) Milkhouses should be designed to permit the installation of milk cooling facilities, as well as subsequent removal for service or repairs.

(e) Drains:

(i) Milkhouses should have a minimum of one trapped drain 4 in. or more in diameter plus sink drains suitably trapped.

**4.1.1.1** (3) (e)

(ii) The drains should not be located directly under the outlets for a farm holding tank.

(iii) All drains should be suitably vented.

(f) Ventilation and lighting should be as given in Section 3.2 and clauses 3.4.9.5 and 3.4.9.6 respectively.

(g) Milkhouses with Holding Tanks:

(i) A milkhouse in which a holding tank is installed, or is to be installed, should have a reinforced concrete floor with a gradient of not less than ¼ in. in 1 ft. to the drain.

(ii) The lights should be so located that they illuminate the inside of the tank when lids are open.

(iii) A milkhouse should be equipped with a hose-port having a self-closing trap door at least 6 in. above the milkhouse floor or the outside ground level, whichever is higher, and should be located directly opposite the outlet valve on the holding tank.

(iv) The space between the top of a farm holding tank and the ceiling of the milkhouse should be sufficient to permit removal of the tank measuring rod but in no case less than 36 in.

(v) Space should be provided in milkhouses to permit a farm bulk tank to be installed at least 6 in. above the floor of the milkhouse; but in the case of a tank with a rounded bottom, the lowest portion of the tank should be not less than 4 in. above the floor.

(vi) There should be an outside paved walk from the hose-port to the main milkhouse entry door.

(vii) A milkhouse should be large enough to provide a minimum of 2-ft. clearance between the sides of the farm holding tank and any wall of the milkhouse; and adequate additional space should be allowed for normal milkhouse operations.

(viii) The dimensions of a milkhouse should provide 2 ft. of clearance between a surface cooler, if used, and a bulk holding tank. In addition, a clearance of 2 ft. 6 in. should be provided between the top of the pouring tank of the surface cooler and the ceiling. The cooler should not be placed over the holding tank.

(h) Milkhouses should provide space for

(i) a hot water tank of not less than 40-gal. capacity;

(ii) double wash-sinks with mixing taps supplying hot and cold water;

**4.1.1.1** (3) (h)

(iii) drain boards and racks.

(4) *Milk Stands*

Milk stands should be constructed to protect milk and milk cans from dust, direct rays of the sun, frost, rain, and from any conditions or substances likely to impart odors or be detrimental to the quality of milk or manufactured milk products.

**4.1.1.2 Raw Milk Production**—

(1) All details presented under clause 4.1.1.1 will apply to the structures used for raw milk production.

(2) Milkhouses should contain

(a) a cooling and bottling room,

(b) cold storage facilities,

(c) a room for washing and sterilizing utensils,

(d) a boiler room, and

(e) a room for toilet facilities.

(3) Toilet rooms should provide space for hand-washing facilities and should open to either

(a) the boiler room or the room provided for washing, or

(b) a hallway, but not directly opposite a doorway entering the bottling or storage room.

(4) Space should be provided in a milkroom for proper storage of utensils used in that room.

**4.1.2 Poultry Production**

**4.1.2.1 Egg Grading**—

(1) The floors in egg-grading rooms should be constructed of concrete or equivalent material finished with a smooth surface throughout, and should be graded to a suitably trapped drain.

(2) Ventilation should be provided in egg-grading rooms.

**4.1.3 Honey Processing Structures**

(1) All buildings or rooms in which honey is to be extracted, packed or stored, should be constructed in such a manner that they may be maintained in a clean and sanitary condition.

(2) The structure should provide space for all equipment including extractors, pumps, tanks, uncapping machines, remelting equipment, storage or supers, and containers.

(3) The structure should incorporate washing facilities and suitable drainage, properly trapped to permit the maintenance of sanitary conditions.

(4) If a lavatory is constructed in the structure, it should be in a separate room, properly drained and ventilated, and should have, in or adjacent to it, a hand-basin for washing.

### 4.1.4 Contagious Disease Control Structures

(1) *Isolation Rooms*

(a) Isolation rooms should be constructed to permit ready cleaning and disinfecting of the area.

(b) Floors should be constructed of concrete or other similar material coved to walls which are concrete or other similar material for a minimum of 12 in. above the floor level.

(c) Walls and ceilings should be constructed of materials and finish which will be smooth and non-absorbent.

(d) Isolation rooms should be fitted with a drain separate from the main barn drainage.

(e) Individual ventilation systems should be provided.

(2) *Box Stall*

Where a box stall only is used for isolation, it should have a complete passageway around the stall and solid walls to a height of 5 ft.

### 4.1.5 Fur Production

**4.1.5.1 Mink**—

(1) Buildings for housing mink should

(a) be located on ground which has good water drainage both surface and sub-drainage,

(b) be located where snowdrifting does not create problems, and

(c) have earthen floors bedded slightly to facilitate dropping removal.

(2) The structures should incorporate isolation cages if the operator is to exhibit live animals in fur shows. These cages should be in a separate area and should be serviced last in any feeding and cleaning operations.

(3) The structures should be surrounded by a guard fence designed to exclude other animals.

(4) A feed room should

(a) be attached directly to the compound,

(b) have a refrigeration room for minus twenty-degree freezing of feed, together with a portion for zero-degree holding, and

(c) include a grinding and mixing room.

(5) A pelting room should be provided for killing, cooling, pelting, fleshing, cleaning and stretching of the fur product.

**4.1.5.2 Other Animals**—The general sanitation requirements set out for mink structures will apply to structures for other fur-bearing animals.

## 4.2 WASTE DISPOSAL

### 4.2.1 Animal and Poultry Excreta

Animal and poultry excreta should be disposed of according to the best methods outlined under subsections 3.6.3 and 3.6.4.

### 4.2.2 Viscera, Dead Animals and Birds

Viscera, dead animals or birds, and potentially diseased or diseased wastes should be disposed of according to the best methods outlined in clause 3.6.4.2.

### 4.2.3 Drainage

(1) Plumbing for drainage should meet the requirements of the "National Building Code of Canada", and information set out in Supplement No. 4 "Handbook of Plumbing Sketches", except that the "Bell Trap" shown under Section 3, "Traps (1)", "Prohibited Traps (B)", may be used in livestock buildings.

(2) Surface slopes for drainage should be as follows

| | |
|---|---|
| Livestock floors, minimum slope | — ⅛ in. per ft. |
| Hog floors, bedded area | — ⅛ in. slope per ft. |
| Hog floors, dunging area | — ½ in. slope per ft. |
| Yard slabs, slope | — ¼ in. per ft. |
| Dairy floors, slope | — ¼ in. per ft. |
| Dairy barn gutters | |
| for mechanical cleaners | — zero gradient |

# APPENDIX A
# Unit Weights of Materials

## TABLE A-1

### Unit Weights of Construction Materials and Units

| Materials and Units | Unit Weight |
|---|---|
| **MATERIALS** | **lb./cu. ft.** |
| Cast stone masonry | 144 |
| Cinder fill | 57 |
| Concrete— | |
| plain | 144 |
| expanded slag | 100 |
| haydite | 90 |
| slag | 132 |
| stone | 144 |
| Concrete— | |
| reinforced | 150 |
| hollow tile (bearing) | 60 |
| Masonry, brick— | |
| hard | 130 |
| medium | 115 |
| soft | 100 |
| Plaster, mortar | 96 |
| Timber, seasoned— | |
| Ash, white | 41 |
| Douglas fir | 32 |
| Hemlock | 28 |
| Pine | 30 |
| Spruce | 28 |
| Western Cedar | 24 |
| **UNITS** | **lb./sq. ft.** |
| Single roof, including framing | 6—10 |
| Slate roof and framing | 12—15 |
| Tar and gravel roof | 10—12 |
| Partitions— | |
| wood | 15—20 |
| hollow masonry | 15—30 |
| Walls— | |
| 8-in. concrete blocks | 33—59 |
| 12-in. concrete blocks | 54—97 |
| Floors— | |
| wood | 10—15 |
| 6-in. concrete | 70—80 |
| Walls— | |
| 4-in. clay brick | 40 |
| 4-in. clay tile | 18 |
| 4-in. concrete brick | |
| —heavy | 46 |
| —light | 33 |
| Walls— | |
| 4-in. glass block | 18 |
| 8-in. clay brick | 80 |
| 8-in. concrete block | 55 |
| —light block | 35 |
| 8-in. clay tile | 42 |

TABLE A-1 (Cont'd)

| Materials and Units | Unit Weight |
|---|---|
| **UNITS (cont'd)** | |
| 12-in. clay tile | 58 |
| Wood, 2 x 4, plastered | 20 |
| Concrete floor slabs (per inch thickness)— | |
| stone, reinforced | 12½ |
| plain | 12 |
| Cinder, reinforced | 9 |
| Light-weight aggregate | 8 |
| Wood-joist floors 16-in. | |
| Double wood floor 2 in.— | |
| 2 x 6 joists | 5 |
| 2 x 8 joists | 6 |
| 2 x 10 joists | 6 |
| 2 x 12 joists | 7 |
| Roof Coverings— | |
| aluminum | 1/3 |
| asbestos shingles | 4 |
| asphalt shingles | 6 |
| corrugated steel | 1 |
| 5-ply felt and gravel | 6 |
| Lumber— | |
| sheathing (per inch thickness) | 3 |
| wood shingles | 3 |
| wood shakes | 5 |
| Fir Plywood (thickness in inches)— | |
| 5/16 | 1.0 |
| ⅜ | 1.2 |
| ½ | 1.5 |
| ⅝ | 1.8 |
| ¾ | 2.2 |

## TABLE A-II

### Apparent Densities of Agricultural Materials

| Material | Apparent Density lb./cu. ft. | Remarks |
|---|---|---|
| **Grains—** | | |
| Barley | 40 | |
| Beans | 48 | |
| Corn— | | |
| shelled | 45 | |
| ear* | 28 | |
| chopped ear | 35 | |
| hammered shelled | 36—44 | |
| Flaxseed | 45 | |
| Oats— | 25—35 | |
| ground or rolled | 19—25 | |
| Rapeseed— | | |
| Polish | 40 | |
| Argentine | 48 | |
| Rice | 36 | |
| Rye | 45 | |
| Soybeans | 48 | |
| Wheat | 48 | |
| Wheat, ground | 38 | |
| *2 cu. ft. of husked ear corn will yield approximately 1 cu. ft. of shelled corn. | | |
| **Concentrated Feeds—** | | |
| Alfalfa meal, dehydrated | 16—22 | |
| Alfalfa pellets | 41—43 | |
| Beet pulp, dried | 11—16 | |
| Brewers grains— | | |
| dried | 14—15 | |
| wet | 55—60 | |
| Bone meal | 50—53 | |
| Fish meal | 30—34 | |
| Meat meal | 37 | |
| Linseed oil meal | 32 | |
| Soya bean oil meal | 34—42 | |
| Salt | 62—70 | |
| Wheat, bran | 11—16 | |
| Wheat middlings | 18—25 | |
| Pelleted ration | 37—39 | |
| Crumbled ration | 34 | |

TABLE A-II (Cont'd)

| Material | Apparent Density lb./cu. ft. | Remarks |
|---|---|---|
| **Roughage Feeds and Bedding—** | | |
| Hay | | |
| —long | 4—5 | |
| —chopped | 8—10 | (mow drying) |
| —baled | 6—14 | |
| —wafered | 20 | |
| Silage | | |
| —stored 8′ deep, average | 35 | Moisture content of 70% wet basis |
| —stored 30′ deep, average | 41 | |
| —stored 40′ deep, average | 47 | |
| —stored 50′ deep, average | 51 | |
| —stored 60′ deep, average | 56 | |
| Straw | | |
| —long | 35—4 | |
| —chopped | 6—8 | |
| —loose baled | 7—8 | |
| Wood shavings, baled | 20 | |
| **Fruits and Vegetables—** | | |
| Apples | 38 | Inside dimensions of box 10½ x 11½ x 18 inches |
| Beans | | |
| —unshelled | 25 | |
| —shelled | 48 | |
| Carrots | 40 | |
| Cherries | | |
| —with stems | 45 | |
| —without stems | 51 | |
| Cranberries | 30 | |
| Onions, dry | 40—46 | |
| Potatoes | 42 | |
| Apples (stacked in bushel boxes) | 30 | |
| **Miscellaneous Products—** | | |
| Eggs in cases | 12 | |
| Tobacco | 35 | |
| Wool | | |
| —compressed bales | 48 | |
| —uncompressed bales | 13 | |
| Fertilizer | 35—40 | |
| Portland cement | 87—94 | |
| Coal | | |
| —anthracite | 47—58 | |
| —bituminous | 40—54 | |

# APPENDIX B
# Vehicle and Equipment Storage

## TABLE B-1

### Areas and Dimensions of Farm Vehicles and Equipment

| ITEM | Length* Ft. | Width Ft. | Height Ft. | Occupied Area** Sq. Ft. |
|---|---|---|---|---|
| Automobile | 18 | 7 | 6 | 126 |
| Truck— | | | | |
| pickup, 6½ foot box | 16 | 6½ | 6 | 104 |
| pickup, 8 foot box | 17½ | 6½ | 6 | 114 |
| livestock rack | 26 | 8 | 10 | 208 |
| grain bed | 26 | 8 | 7 | 208 |
| Tractor— | | | | |
| one-plow size | 9 | 5 | 5 | 45 |
| two-plow, utility type | 10 | 5½ | 6½ | 52 |
| three-plow, utility type | 11 | 6½ | 7 | 70 |
| three-plow, tricycle row-crop type | 12½ | 7½ | 7½ | 70 |
| four plow | 13 | 7½ | 8½ | 95 |
| Plow, tractor-drawn— | | | | |
| two-furrow, mounted | 5 | 3 | | 12 |
| three-furrow, mounted, | | | | |
| —no tail wheel | 7 | 4 | | 26 |
| —with tail wheel | 8 | 4 | | 32 |
| four-furrow, mounted | 11½ | 5 | | 48 |
| two-furrow, wheel type | 12½ | 5½ | | 50 |
| three-furrow, wheel type | 14½ | 6½ | | 65 |
| four-furrow, wheel type | 16½ | 7 | | 92 |
| Disc Harrow— | | | | |
| 8 ft. tractor-mounted | 9½ | 9 | 2½ | 60 |
| 8 ft. transport-wheel type | 10 | 9 | | 65 |
| 10 ft. transport-wheel type | 10½ | 11 | | 83 |
| Field Cultivator— | | | | |
| 8 ft. tractor-mounted | 4 | 8 | | 25 |
| 10 ft. tractor-mounted | 6½ | 10 | | 48 |
| One-way Disc | 14 | 9 | | 100 |
| Row-Crop Cultivator— | | | | |
| 2-row, tractor-type, demounted | | | | 55 |
| 4-row | 8 | 15 | | 100 |
| Rotary-Hoe | 6 | 10 | 3 | 50 |
| Grain-Fertilizer Drill— | | | | |
| 13 x 7, tractor-drawn | 9 | 10 | 5½ | 60 |
| 15 x 7, tractor-drawn | 9 | 11 | 5½ | 50 |
| 18 x 7, tractor-drawn | 10 | 12⅔ | 6 | 80 |
| 24 x 7, tractor-drawn | 11 | 18 | 6 | 140 |
| Corn Planter— | | | | |
| 2-row, tractor-mounted | 6½ | 5 | 6 | 30 |
| 4-row, tractor-mounted | 6½ | 12 | 9 | 78 |
| 4-row, tractor-drawn | 10½ | 12 | 9 | 90 |

TABLE B-I (cont'd)

| ITEM | Length* Ft. | Width Ft. | Height Ft. | Occupied Area** Sq. Ft. |
|---|---|---|---|---|
| Potato Planter— | | | | |
| 1-row | 8½ | 4 | 5 | 24 |
| 2-row | 8½ | 6 | 5 | 36 |
| Wheeled Fertilizer Spreader— | | | | |
| 8-ft. spreading width | 7 | 9⅔ | | 48 |
| 10-ft. spreading width | 7 | 11⅔ | | 58 |
| Mower— | | | | |
| horse-drawn, 6 ft. bar up | 14 | 5 | 6½ | 40 |
| tractor-drawn, 7 ft. bar up | 7 | 7 | 7½ | 28 |
| tractor rear-mounted, 7 ft. bar up | 3 | 5 | 8 | 14 |
| tractor mid-mounted, 7 ft. bar down | 5½ | 10½ | | 26 |
| Rake— | | | | |
| 12 ft. dump rake, horse-drawn | 14 | 14 | 4½ | 80 |
| side delivery, tractor-drawn | 12 | 12½ | 4½ | 108 |
| Hay Conditioner | 6 | 9½ | 2½ | 42 |
| Baler | 17 | 9 | 5½ | 100 |
| Bale Stooker | 6 | 5½ | 3½ | 33 |
| Wagon— | | | | |
| flat platform | 16 | 8 | 3 | 128 |
| self-unloading all-purpose wagon | 20 | 8 (without side ext.) | 11 | 160 |
| V-bottom auger wagon (125 bu.) | 10 | 6 | 12 (with 9 auger) | 54 |
| hoppered grain wagon | 10½ | 7 | 7 (with 12″ side ext.) | 75 |
| Forage Harvester— | | | | |
| tractor-drawn, 2-row corn head | 15 | 9½ | 10 | 136 |
| windrow pickup attachment | 6 | 6 | 4 | 27 |
| Forage Blower, in transport position— | | | | |
| long hopper type | 15½ | 6 | 6 | 80 |
| short hopper type | 8½ | 5½ | 6 | 47 |
| Corn Picker— | | | | |
| 1-row, pull type | 10 | 8 | 10½ | 80 |
| 2-row, pull type | 14 | 11 | 10½ | 132 |
| Potato Digger— | 8 | 5 | | 40 |

TABLE B-I (cont'd)

| ITEM | Length* Ft. | Width Ft. | Height Ft. | Occupied Area** Sq. Ft. |
|---|---|---|---|---|
| Swather, self-propelled— | | | | |
| 10 ft. cut | 19 | 11½ | 6½ | 190 |
| 12 ft. cut | 19 | 13½ | 6½ | 230 |
| 14 ft. cut | 19 | 15½ | 6½ | 270 |
| 16 ft. cut | 19 | 17½ | 6½ | 300 |
| Combine, self-propelled— | | | | |
| 10 ft. cut | 23 | 11½ | 13*** | 250 |
| 12 ft. cut | 23 | 13½ | 13*** | 270 |
| 14 ft. cut | 23 | 15½ | 13*** | 290 |
| 16 ft. cut | 23 | 18½ | 13*** | 310 |
| Combine, pull-type— | | | | |
| 6 ft. cut | 22½ | 10 | 9½ | 200 |
| 10 ft. cut, tongue in transport position | 22½ | 11½ | 10 | 220 |
| Stalk Shredder— | | | | |
| vertical shaft, single rotor, mounted | 7 | 6 | 3 | 37 |
| horizontal shaft, with hood, wheeled | 9½ | 9½ | 10 | 75 |
| Manure Spreader, tractor, 125 bu. | 18½ | 6½ | 5½ | 100 |
| Manure Loader, removed from tractor | 9 | 4 | | 36 |
| Utility Blade, tractor rear-mounted | 3½ | 6 | | 12 |
| Feed Grinder-Mixer Unit, tractor-drawn, p.t.o. driven | 12½ | 8½ | 8⅔ | 70 |
| Bale Elevator, wheeled, 40 ft. | 40 | 7½ | | 80 |
| Potato Planter— | | | | |
| 4-row | 12 | 13 | 5¼ | 120 |
| Potato Harvester— | | | | |
| 1-row | 27 | 12 | 10 | 175 |
| 2-row | 27 | 15 | 10 | 200 |
| Potato Sprayer | 13 | 8½ | 7 | 110 |

* Length of machines includes the length of rigid draw tongues where used. The lengths of swinging tongues, such as on 4-wheeled farm wagons, are not included.

** Occupied area is not necessarily the product of length times width for all machines. Where the occupied area listed is less than the rectangular area, a deduction has been made for that part of the rectangular area, which could be used for other storage.

*** A few current self-propelled combines are almost 13 ft. high. The majority of these machines are, however, 12 ft. high or less. Construction of implement storage to clear a combine 13 ft. high may not be necessary. Reference should be made to the specifications prepared by combine manufacturers.

# APPENDIX C

## Loads Imposed by Stored Grain and Silage

## LOADS IMPOSED BY STORED GRAIN

### DEFINITIONS

(*1*) *Shallow Bin:*

Depth of grain (H) less than or equal to equivalent diameter (D).

Or: $\frac{H}{B} < \tan\left(\frac{\varnothing}{2} + 45°\right)$

B = width. $\varnothing$ = emptying angle of repose.

(i.e., wheat: $\varnothing = 28°$, if H = 1.66 B or less use shallow bin design.)

(*2*) *Deep Bin:*

Depth of grain (H) greater than the equivalent diameter (D).

Or: greater than second definition above.

(*3*) *Equivalent Diameter (D):*

Round bins: D = bin diameter.

Rectangular bins: D = 4(floor area)/(perimeter).

Use building width instead of D if length is more than 1½ width.

(*4*) *Equivalent Fluid Density (EFD):*

Grain is a semi-fluid. Loads, both vertical and lateral, are a function of depth. In the design of some bins, discussed later, the EFD directly relates load and depth, assuming linearity.

From Rankine's development:

Lateral pressure (L) = EFD $\times$ $H^2/_2$,

where EFD = r $\tan^2(45° - \varnothing/2)$.

r = density of material

$\varnothing$ = angle of internal friction

(use emptying angle of repose to compute EFD)

### A. SHALLOW BINS

(*1*) *Lateral load on vertical walls:*

L = EFD $\times$ H.

(*2*) *Vertical loads on vertical walls:*

V = u′ $\times$ L. u′ = coefficient of friction, grain on wall.

(*3*) *Vertical loads on horizontal floors:*

V = EFD $\times$ H.

Conservative: V = Bulk Density $\times$ H.

(*4*) *Design values—Equivalent fluid density (EFD):*

Level fill: shelled corn, 18.5 pcf

wheat, 16 pcf

Effect of storage time: increase above figures 25% for storage longer than one year.

Effect of surcharge: increase above figures 25% for maximum surcharge.

(Note: These figures have checked out in extensive loading and pressure studies. They also agree with Rankine's formula, using emptying angle of repose for angle of internal friction. See apparent inconsistency with data under Coulomb's theory below.)

(*5*) *Inward sloping, or inward curving walls:*

EFD pressures will result in conservative designs.

Use Coulomb's "wedge" theory.

(Note: With level fill and zero wall friction, Coulomb's theory reduces to Rankine's theory.)

(*6*) *Design values—Coulomb's theory:*

The angle of internal friction as determined from loading studies does not equal the unloading angle of repose as commonly used in the EFD method.

Angle of internal friction: shelled corn, 22°

wheat, 31°

## B. DEEP BINS

Janssen's formula:

(*1*) *Lateral load on vertical walls:*

$$L = \frac{wD}{4u'}\,(1-e^{-4Ku'\,H/D})$$

L = lateral pressure, psf
w = material density, pcf
D = bin diameter, or equivalent diameter, ft.
K = ratio of lateral to vertical internal pressure = $(1-\sin\varnothing)/(1+\cos\varnothing)$
$\varnothing$ = angle of repose
u′ = coefficient of friction, material on wall
H = depth of fill, ft.
V = u′L = vertical load on wall

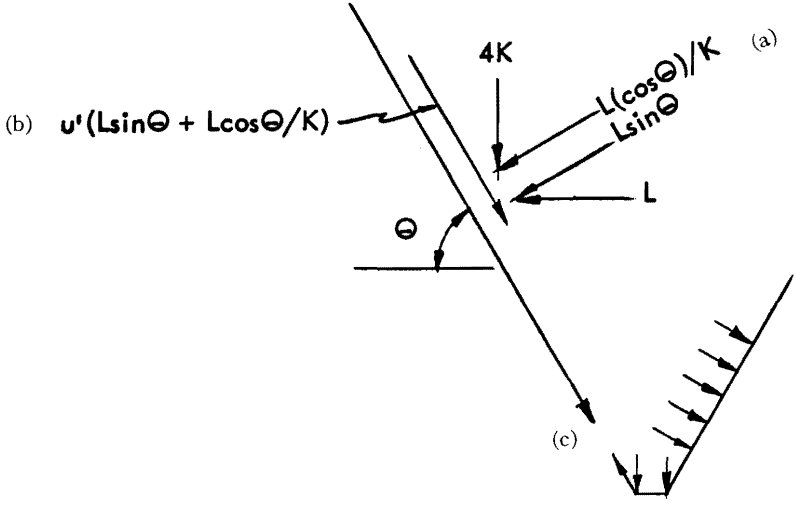
(*2*) *Vertical load on vertical walls:*
$V = u' \times L.$
Note: Vertical load and horizontal load may never be maximum at the same time.

(*3*) *Vertical load on horizontal floors:*
$F = L/K$

## C. HOPPER BOTTOMS

(*1*) *Coulomb's theory will work for shallow bins with sloping walls and/or floors.*

(*2*) *Deep Bins—at any given depth, the forces on the hopper surface are:*
(a) Normal force = $L \sin\Theta + L/K \cos\Theta$
where $\Theta$ is the angle between the hopper surface and the horizontal.
(This formula is reported to be too conservative for deep bins.)
(b) Friction force parallel to surface = Normal force × u′.
(c) Vertical tensile stress resulting from the lower end of a hopper face providing end reactions to another face.
(d) Hoop stress in conical hoppers, or
Horizontal tensile stress resulting from one face of the hopper providing end reactions to other faces.

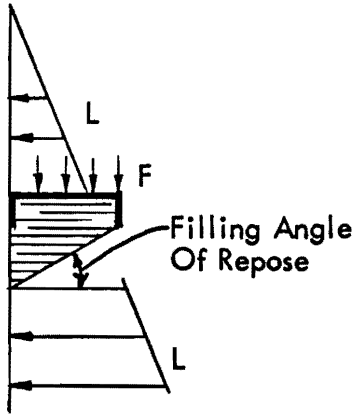


## D. VERTICAL LOADS ON WALLS WITH EXPOSED HORIZONTAL GIRTS

Wall Load = F + V

F = vertical load on girts.

V = u′ × L = vertical load on wall. In computing L, omit those areas "shaded" by the girts.




## E. THERMAL EFFECTS

Coefficient of linear thermal expansion for 9.3% corn = 0.0000187 in/in.

Temperature changes of ambient air will result in dimensional changes in the bin, and lower and/or smaller changes in the stored material. Differential changes between the bin and stored material result.

Sun warming of the bin surface, followed by settling of the stored material and subsequent cooling, may result in passive pressures. Because dimensional changes will be relatively small, elasticity of a grain mass (340 to 1000 psi) will permit yielding to reduce the apparent high stresses.

Yielding of the grain mass is reported to increase the EFD significantly as well as changing the stress patterns in the grain. Repeated cycles may lead to failure.

## F. MOISTURE EFFECTS

In commercial warehousing and farm bins with the grain put in at safe moisture contents and with no drying anticipated, moisture changes are not important to structural design.

Wall pressures will increase at least 6 times if the moisture content of dry grain is raised 4%. Pressures will increase 10 times with a 10% moisture increase.

## G. UNLOADING EFFECTS

A number of investigators report varying amounts of overloading during grain discharge.

No design values or procedures seem to be available at this time.

## H. PHYSICAL PROPERTIES OF STORED CROPS

See Table C-I.

TABLE C—I

Coefficients of Friction (U) for Grains at Various Moisture Contents on Various Surfaces

| Material | Moisture Content % | Surfaces | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Concrete | | | Wood | | | | Plastic | | Metal | |
| | | | | | Oak | | Douglas Fir | | | | | |
| | | Plastic Smooth Finish | Steel Trowel Finish | Wood Float Finish | Grain Par. | Grain Perp. | Grain Par. | Grain Perp. | Teflon | Poly-ethy-lene | Mild Steel C.R. | Gal-vanized Sheet Metal |
| Oats | 10.6 | .276 | .396 | .434 | .202 | .231 | .268 | .294 | .130 | .204 | .197 | .223 |
| | 13.0 | .343 | .443 | .435 | .244 | .251 | .289 | .354 | .139 | .239 | .256 | .240 |
| | 14.0 | .326 | .514 | .423 | .232 | .248 | .343 | .358 | .126 | .278 | .214 | .180 |
| | 16.0 | .292 | .459 | .456 | .314 | .307 | .371 | .366 | .110 | .312 | .204 | .405 |
| | 17.3 | .497 | .652 | .639 | .459 | .479 | .480 | .500 | .135 | .502 | .443 | .315 |
| Spheres (Teflon) | | .322 | .398 | .375 | .300 | .323 | .330 | .354 | .243 | .280 | .213 | .248 |
| Wheat | 11.2 | .356 | .516 | .506 | .235 | .264 | .307 | .347 | .170 | .269 | .204 | .095 |
| | 13.0 | .460 | .520 | .546 | .247 | .291 | .345 | .382 | .156 | .351 | .286 | .142 |
| | 15.0 | .503 | .547 | .510 | .353 | .368 | .468 | .457 | .146 | .389 | .269 | .272 |
| | 15.7 | .563 | .677 | .689 | .411 | .464 | .482 | .501 | .119 | .448 | .514 | .332 |
| Soybeans | 7.1 | .246 | .390 | .391 | .239 | .337 | .290 | .309 | .160 | .246 | .191 | .206 |
| | 8.1 | .318 | .554 | .515 | .294 | .336 | .323 | .366 | .174 | .316 | .192 | .205 |
| | 9.8 | .308 | .467 | .367 | .281 | .308 | .333 | .314 | .155 | .288 | .202 | .182 |
| | 12.2 | .363 | .552 | .515 | .279 | .360 | .353 | .441 | .147 | .430 | .230 | .199 |
| Barley | 10.7 | .232 | .557 | .503 | .234 | .285 | .269 | .322 | .169 | .232 | .197 | .198 |
| | 12.3 | .248 | .547 | .522 | .214 | .277 | .275 | .306 | .147 | .275 | .247 | .174 |
| | 14.3 | .236 | .568 | .508 | .205 | .277 | .297 | .323 | .131 | .278 | .288 | .204 |
| | 16.4 | .331 | .619 | .552 | .304 | .330 | .374 | .412 | .105 | .354 | .214 | .342 |

TABLE C—I (cont'd)

| Material | Moisture Content % | Surfaces | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Concrete | | | Wood | | | | Plastic | | Metal | |
| | | | | | Oak | | Douglas Fir | | | | | |
| | | Plastic Smooth Finish | Steel Trowel Finish | Wood Float Finish | Grain Par. | Grain Perp. | Grain Par. | Grain Perp. | Teflon | Poly-ethyl-lene | Mild Steel C.R. | Gal-vanized Sheet Metal |
| Shelled Corn | 7.5 | .268 | .405 | .456 | .238 | .245 | .271 | .288 | .170 | .219 | .225 | .195 |
| | 9.9 | .247 | .589 | .615 | .282 | .314 | .314 | .314 | .176 | .270 | .201 | .241 |
| | 12.2 | .331 | .677 | .647 | .261 | .291 | .330 | .333 | .160 | .303 | .201 | .246 |
| | 13.9 | .345 | .635 | .540 | .294 | .360 | .365 | .380 | .123 | .381 | .238 | .372 |
| Alfalfa | 82.0 | .737 | .686 | .775 | .610 | .674 | .697 | .614 | .191 | .610 | .653 | .535 |
| | 33.3 | .478 | .562 | .714 | .373 | .478 | .393 | .488 | .179 | .394 | .510 | .374 |
| | 22.2 | .328 | .649 | .655 | .310 | .333 | .334 | .374 | .160 | .320 | .458 | .359 |
| Alfalfa 75% Timothy 25% | 77.0 | .631 | .677 | .775 | .576 | .603 | .603 | .698 | .266 | .645 | .650 | .644 |
| | 26.2 | .269 | .488 | .727 | .306 | .391 | .361 | .423 | .191 | .332 | .363 | .375 |
| | 21.3 | .258 | .486 | .616 | .312 | .355 | .315 | .386 | .197 | .194 | .345 | .266 |
| Alfalfa 25% Timothy 75% | 81.1 | .619 | .686 | .827 | .518 | .638 | .659 | .647 | .225 | .618 | .569 | .591 |
| | 49.3 | .514 | .602 | .822 | .437 | .558 | .448 | .585 | .210 | .611 | .431 | .498 |
| | 21.6 | .245 | .530 | .663 | .308 | .379 | .368 | .428 | .203 | .226 | .315 | .291 |
| Timothy | 79.3 | .584 | .598 | .765 | .521 | .532 | .637 | .594 | .226 | .661 | .570 | .526 |
| | 38.1 | .462 | .586 | .777 | .514 | .560 | .534 | .637 | .191 | .517 | .427 | .320 |
| | 30.5 | .373 | .480 | .731 | .441 | .382 | .417 | .522 | .192 | .383 | .388 | .483 |
| | 16.7 | .270 | .446 | .629 | .347 | .423 | .398 | .439 | .215 | .213 | .315 | .318 |
| Bedding { Oat straw | 14.95 | .202 | .360 | .454 | .197 | .260 | .222 | .253 | .139 | .219 | .351 | .304 |
| Bedding { Shavings | 9.5 | .354 | .699 | .725 | .460 | .528 | .427 | .514 | .200 | .294 | .566 | .384 |
| Corn Silage | 78.4 | .456 | .560 | .699 | .583 | .563 | .567 | .581 | .184 | .401 | .569 | .493 |

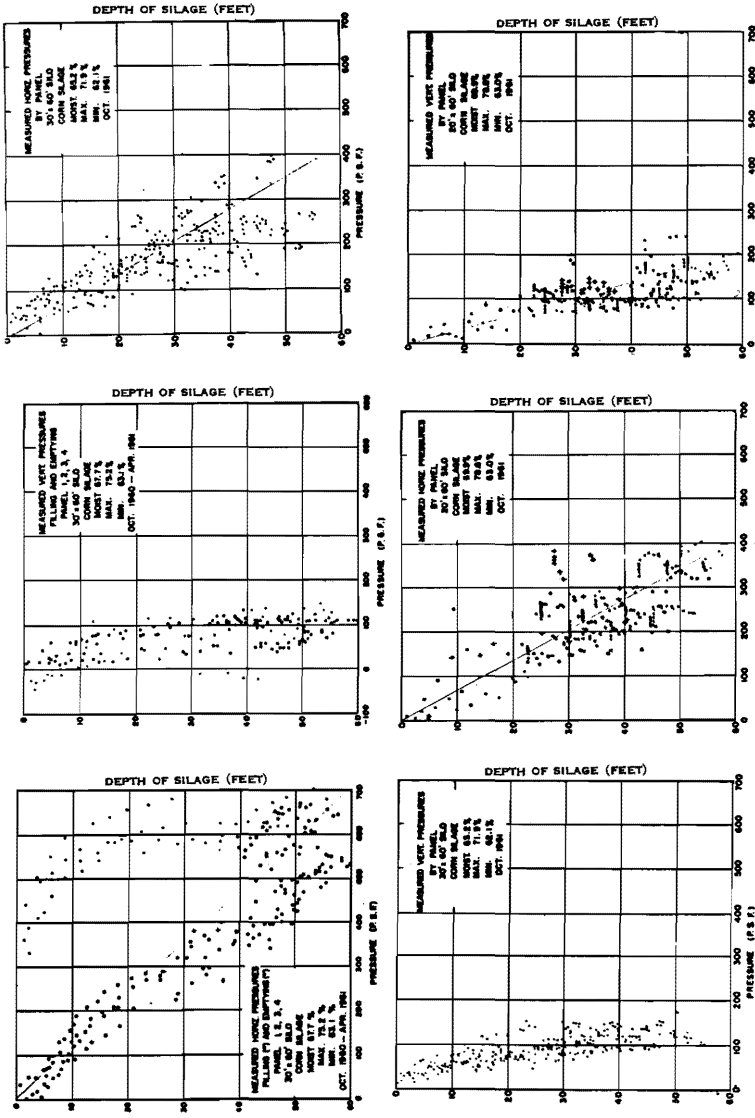



**Figure 1C Lateral Pressures for Corn Silage**

# APPENDIX D
# Concrete and Mortar Mixes

**TABLE D—I**
**Recommended Mortar Mixes**

| Type of Service | Proportions by Volume | |
|---|---|---|
| | Cement or/and Lime | Mortar Sand in Damp Loose Condition |
| For ordinary service | 1 masonry cement<br>or<br>1 portland cement plus 1 hydrated lime | 2¼ to 3<br><br>4½ to 6 |
| Subject to extreme heavy loads, violent winds, or severe frost action, isolated piers | 1 masonry cement plus 1 portland cement<br>or<br>1 portland cement plus ¼ hydrated lime | 4½ to 6<br><br>2¼ to 3 |

## TABLE D—II

### Guide for Ordering Ready-Mixed Concrete

| Specifications for medium consistency concrete (3-in. slump). | Flat Work (with 1½-in. max. size aggregate) | | | Formed Work (with ¾-in. max. size aggregate) | | |
|---|---|---|---|---|---|---|
| | Severe Exposure (garbage feeding floors, floors in dairy plants) | Normal Exposure (paved barnyards, floors for farm building sidewalks) | Mild Exposure (bldg. footings concrete improvements in mild climates) | Severe Exposure (mangers for silage feeding, manure pits) | Normal Exposure (reinforced concrete walls, beams, tanks, foundations) | Mild Exposure (concrete improvements in mild climate) |
| Cement content min. number of bags per cubic yard of concrete | 7½ | 6½ | 5½ | 8½ | 7 | 6 |
| Water content max. number of gallons per bag of cement | 4 | 4¾ | 5½ | 4 | 4¾ | 5½ |
| Probable compression strength at 28 days psi. | 4000 | 3000 | 2500 | 4000 | 3000 | 2500 |

Order air-entrained concrete for all concrete exposed to freezing and thawing and salt action. For 1½-in. maximum size aggregate, specify 4 to 6 per cent air content. For ¾ and 1-in. maximum size, specify 5 to 7 per cent air content.

## TABLE D—III

### Recommended Concrete Mixes for On-the-Job Mixing

| Kind of work | Gal. of water added to each 1-bag batch if sand is— | | | Suggested mixture for 1-bag trial batches**** | | |
|---|---|---|---|---|---|---|
| | Damp* | Wet** (average sand) | Very wet*** | Cement bags (cu. ft.) | Aggregates | |
| | | | | | Fine cu. ft. | Coarse cu. ft. |
| 4 gal. of water per bag of cement. Concrete subjected to severe wear, weather, or weak acid and alkali solutions | With ¾-in. max. size aggregate | | | | | |
| | 3½ | 3 | 2¾ | 1 | 2 | 2¼ |
| 4¾ gal. of water per bag of cement. Floors (such as home, basement, dairy barn) driveways, walks, septic tanks, storage tanks, structural beams, columns and slabs | With 1-in. max. size aggregate | | | | | |
| | 4¼ | 4 | 3¼ | 1 | 2¼ | 3 |
| | With 1½-in. max. size aggregate | | | | | |
| | 4¼ | 4 | 3¼ | 1 | 2½ | 3½ |
| 5½ gal. of water per bag of cement. Foundation walls, footings, mass concrete, etc. | With 1½-in. max. size aggregate | | | | | |
| | 4¾ | 4¼ | 3¾ | 1 | 3 | 4 |

* Damp describes sand that will fall apart after being squeezed in the palm of the hand.

** Wet describes sand that will ball in the hand when squeezed but leaves no moisture on the palm.

*** Very wet describes sand that has been subjected to a recent rain or recently pumped.

**** Mix proportions will vary slightly depending on gradation of aggregates.

# APPENDIX E
## Winter Design Temperatures (5% Basis)

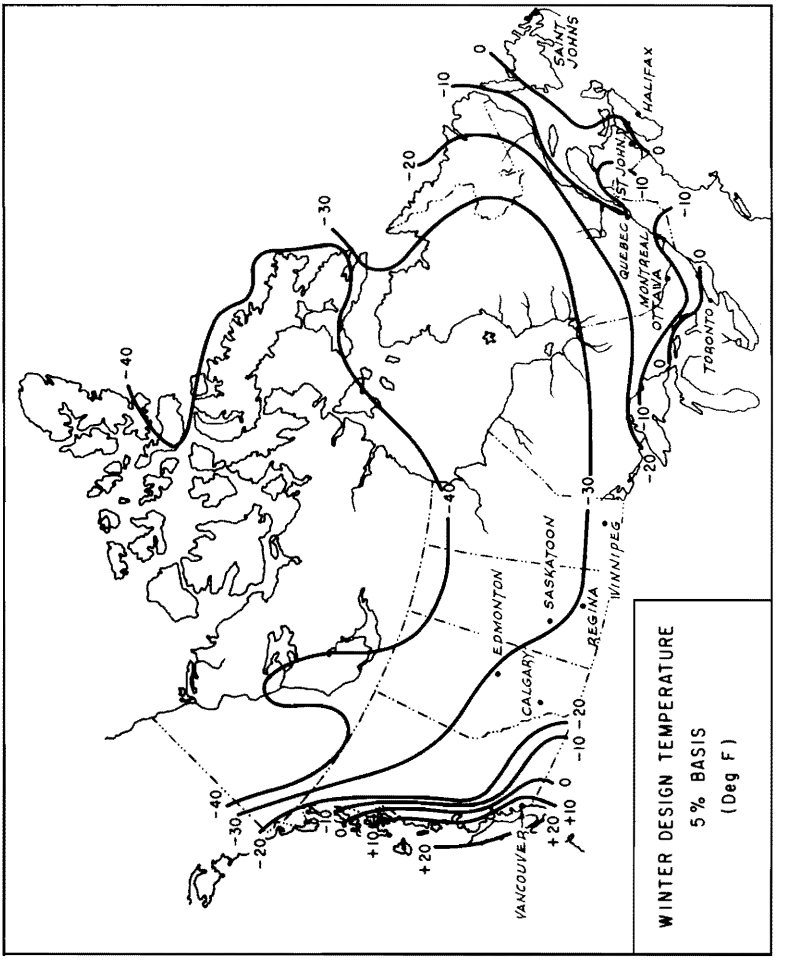



**FIGURE 1E**
**Climatic Zone Map of Canada**

# APPENDIX F

## Heat and Moisture Production of Livestock

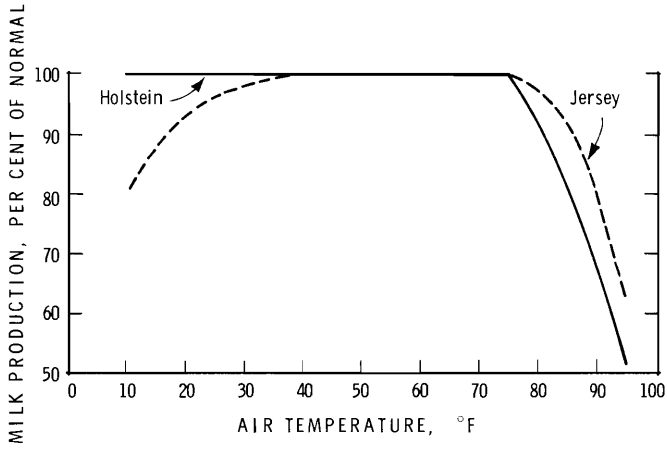
## TABLE F—I
### Guide to Air Flow Requirements in Closed Livestock Buildings

| Livestock | Air Flow in Cubic Feet per Minute | | | | |
|---|---|---|---|---|---|
| | Inside Temp. °F | Outside Temperature | | | |
| | | —20°F | 0°F | 30°F | over 30°F *** |
| Dairy Cows | 40 | 30 | — | — | |
| 1000 lb. | 50 | — | 33 | 54 | |
| Swine | 40 | 9* | 10 | — | |
| 125 lb. | 50 | — | — | 11 | |
| Poultry and Rabbits | 40 | 45* | 52 | — | |
| 350 lb. | 50 | — | — | 110 | |
| Beef Sheep Goats** | | | | | |

* Supplemental heat required at this temperature.

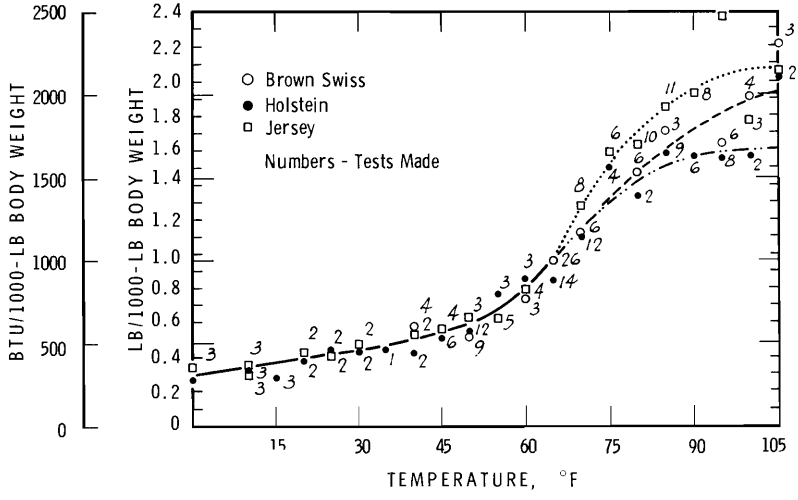
** Not normally housed in closed buildings.

*** Air flow requirements for outside temperatures over 30°F should be calculated on the basis of heat and moisture balance.



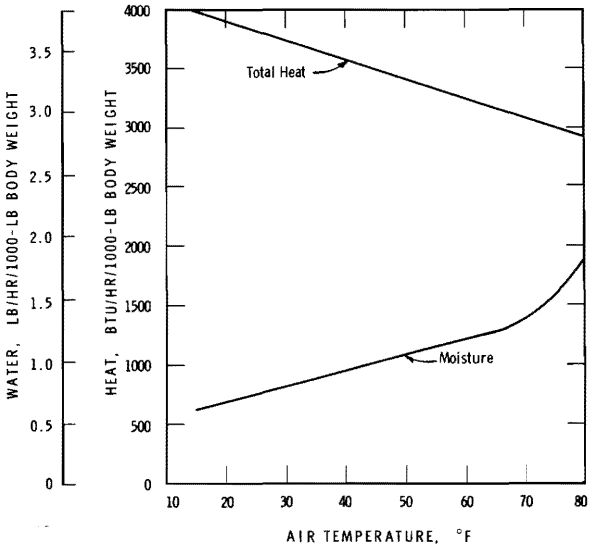

**Per cent of normal milk production at various environmental temperatures. The relative humidity ranged from 55 to 70 per cent.**

## FIGURE 1F
## Milk Production Versus Temperature



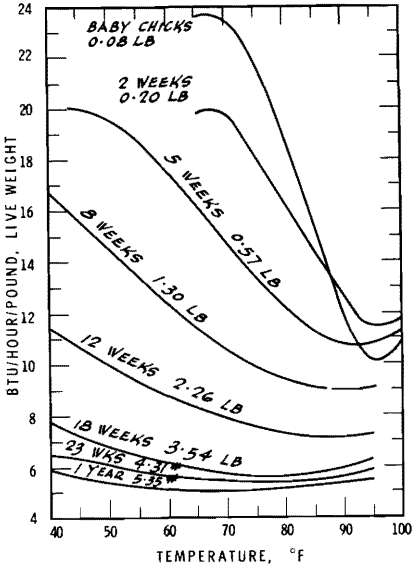

**Total vaporization rates from lactating cows. The relative humidity ranged from 55 to 70 percent.**

## FIGURE 2F
## Evaporation Heat Losses of Cattle




**All data at 55 to 70 per cent relative humidity were pooled for this chart. Stable heat began declining rapidly after 80 F.**

## FIGURE 3F
## Total Heat and Moisture Dissipation Rates with Dairy Cattle and Tie Stalls




## FIGURE 4F
## Total Heat Elimination of Chickens at Various Temperatures Under Basal Conditions

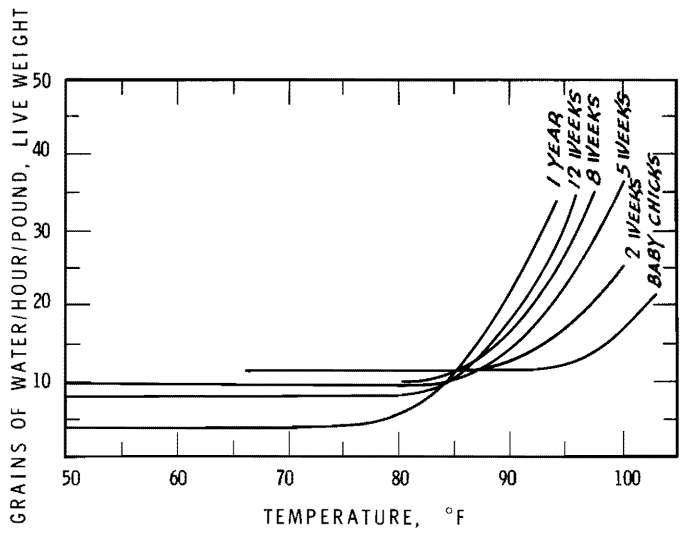



**FIGURE 5F**
**Grains of Moisture (Basal) Respired Per Hour for Different Ages of Chickens and Temperatures**

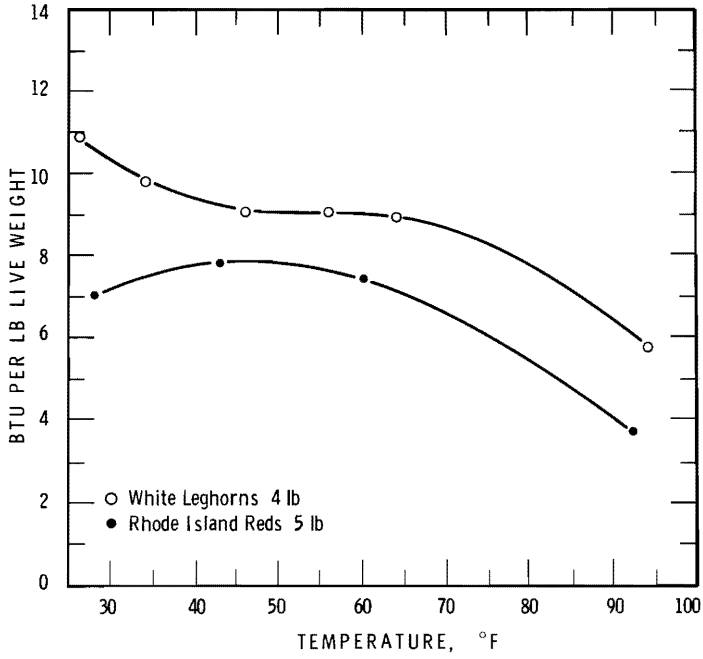



**FIGURE 6F**
**Total Heat Produced by Caged Layers Per Pound of Boby Weight in Relation to Ambient Temperature**

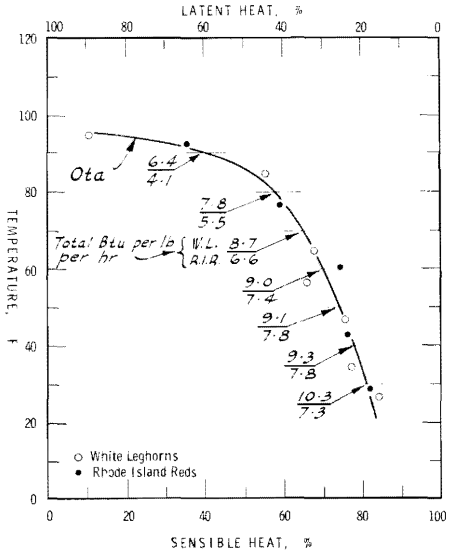



**FIGURE 7F**

**Total Heat Per Pound of Weight and Per Cent of Sensible and Latent Heat Produced by Caged Layers in Relation to Ambient Temperatures**

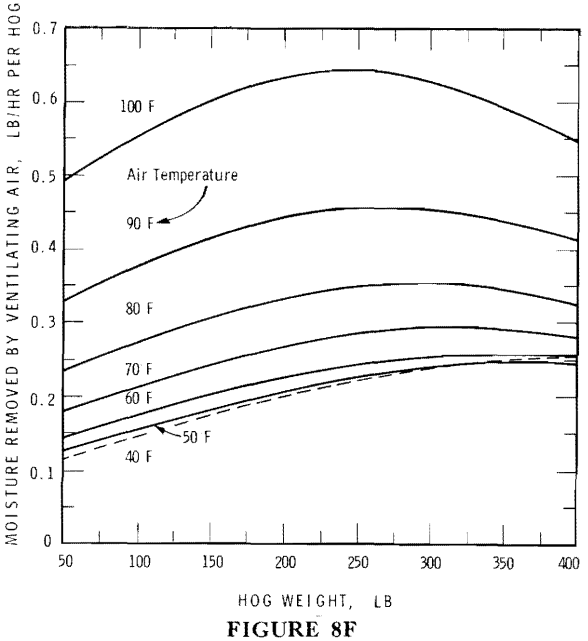



**FIGURE 8F**

**Total Moisture Removed by Ventilation System of Test Room Housing Swine**

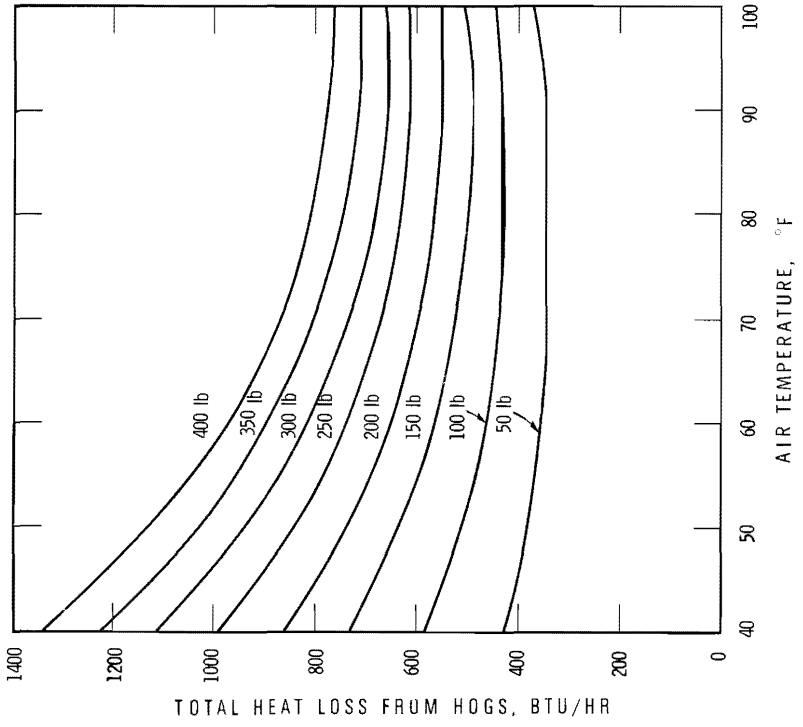



**FIGURE 9F**
**Influence of Ambient Temperature and Animal Weight on Total Heat Lost by Swine**

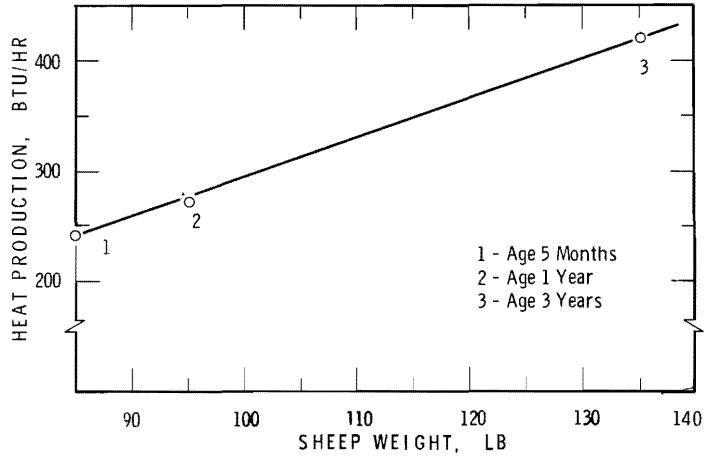



**FIGURE 10F**
**Effect of Sheep Weight upon Heat Production at Air Temperature of 70-72°F**

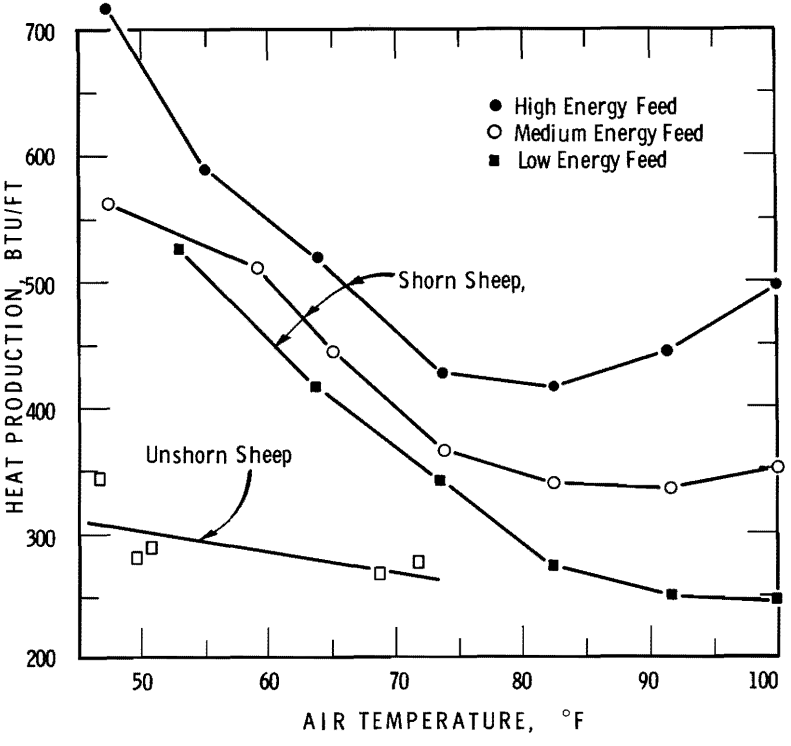



**FIGURE 11F**
**Effect of Air Temperature Upon Heat Production of Sheep**

# APPENDIX G
# Heat of Respiration of Stored Products

## TABLE G—I
## Heat of Respiration of Stored Products

| PRODUCT | Average Freezing Point °F | Per cent Water | Sp ht, Btu/(lb.) (°F) | | Latent Heat of Fusion Btu/lb. | Heat of Respiration | |
|---|---|---|---|---|---|---|---|
| | | | Above Freezing | Below Freezing | | °F | Btu per (24 hr) ton |
| **VEGETABLES—** | | | | | | | |
| Artichokes | 29.1 | 83.7 | 0.87 | 0.45 | 120 | 40 | 10,140 |
| Asparagus | 29.8 | 93 | 0.94 | 0.48 | 134 | 40 | 11,500 |
| Beans, string | 29.7 | 88.9 | 0.91 | 0.47 | 128 | 32 | 4,740 |
| | | | | | | 40 | 6,704 |
| Beans, Lima | 30.1 | 66.5 | 0.73 | 0.40 | 94 | 32 | 2,350 |
| Beans, dried | — | 12.5 | 0.30 | 0.24 | 18 | — | — |
| Beets | 31.1 | 90 | 0.86 | 0.47 | 129 | 32 | 1,166 |
| | | | | | | 40 | 1,820 |
| Broccoli | 29.2 | 89.9 | 0.92 | 0.47 | 130 | 32 | 7,450 |
| | | | | | | 40 | 15,000 |
| Brussels sprouts | 31 | 84.9 | 0.88 | 0.46 | 122 | — | — |
| Cabbage | 31.2 | 92.4 | 0.94 | 0.47 | 132 | — | — |
| Carrots | 29.6 | 88.2 | 0.86 | 0.45 | 126 | 32 | 2,130 |
| | | | | | | 40 | 3,470 |
| Cauliflower | 30.1 | 91.7 | 0.93 | 0.47 | 132 | — | — |
| Celery | 29.7 | 93.7 | 0.95 | 0.48 | 135 | 32 | 2,820 |
| | | | | | | 40 | 4,540 |
| Corn (green) | 28.9 | 75.5 | 0.80 | 0.43 | 108 | 32 | 5,890 |
| Corn (dried) | — | 10.5 | 0.28 | 0.23 | 15 | 40 | 8.190 |
| Cucumbers | 30.5 | 96.1 | 0.97 | 0.49 | 137 | 32 | 1,700 |
| Eggplant | 30.4 | 92.7 | 0.94 | 0.47 | 132 | 60 | 10,450 |
| Endive (escarole) | 30.9 | 93.3 | 0.94 | 0.48 | 132 | — | — |
| Horseradish | 26.4 | 73.4 | 0.78 | 0.42 | 104 | — | — |
| Kale | 30.7 | 86.6 | 0.89 | 0.46 | 124 | — | — |

TABLE G—I (cont'd)

| PRODUCT | Average Freezing Point °F | Per cent Water | Sp ht, Btu/(lb.) (°F) | | Latent Heat of Fusion Btu/lb. | Heat of Respiration | |
|---|---|---|---|---|---|---|---|
| | | | Above Freezing | Below Freezing | | °F | Btu per (24 hr) ton |
| Kohlrabi | 30 | 90 | 0.92 | 0.47 | 128 | — | — |
| Lettuce | 31.2 | 94.8 | 0.96 | 0.48 | 136 | 32 | 11,320 |
| | | | | | | 40 | 15,990 |
| Mushrooms | 30.2 | 91.1 | 0.93 | 0.47 | 130 | 32 | 6,160 |
| | | | | | | 50 | 22,000 |
| Onions | 30.1 | 87.5 | 0.91 | 0.46 | 124 | 32 | 880 |
| | | | | | | 50 | 1,870 |
| Parsnips | 28.9 | 78.6 | 0.84 | 0.46 | 112 | — | — |
| Peas (green) | 30 | 74.3 | 0.79 | 0.42 | 106 | 32 | 8,200 |
| | | | | | | 40 | 14,000 |
| Peas (dried) | — | 9.5 | 0.28 | 0.22 | 14 | — | — |
| Potatoes (white) | 28.9 | 77.8 | 0.82 | 0.43 | 111 | 32 | 660 |
| | | | | | | 40 | 1,430 |
| Pumpkin | 30.1 | 90.5 | 0.92 | 0.47 | 130 | — | — |
| Radishes | 30.1 | 93.6 | 0.95 | 0.48 | 124 | — | — |
| Rhubarb | 28.4 | 94.9 | 0.96 | 0.48 | 134 | — | — |
| Sauerkraut | 26 | 89 | 0.92 | 0.47 | 129 | — | — |
| Spinach | 30.3 | 92.7 | 0.94 | 0.48 | 132 | 40 | 8,000 |
| | | | | | | 60 | 37,500 |
| Squash | 30.1 | 90.5 | 0.92 | 0.47 | 130 | — | — |
| Tomatoes (green) | 30.4 | 94.7 | 0.95 | 0.48 | 134 | 60 | 6,230 |
| Tomatoes (ripening) | 30.4 | 94.1 | 0.95 | 0.48 | 134 | 40 | 1.260 |
| | | | | | | 60 | 5,650 |
| Turnips | 30.5 | 90.9 | 0.93 | 0.40 | 137 | 32 | 66 |
| | | | | | | 40 | 572 |
| Vegetables (mixed) | 30 | 90 | 0.90 | 0.45 | 130 | — | — |

TABLE G—I (cont'd)

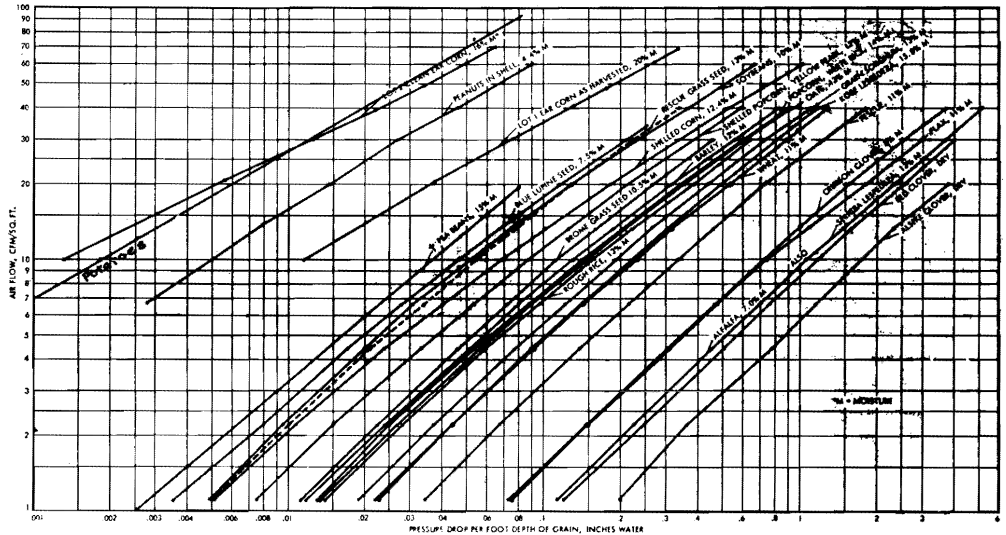
| PRODUCT | Average Freezing Point °F | Per cent Water | Sp ht, Btu/(lb.) (°F) | | Latent Heat of Fusion Btu/lb. | Heat of Respiration | |
|---|---|---|---|---|---|---|---|
| | | | Above Freezing | Below Freezing | | °F | Btu per (24 hr) ton |
| **FRUITS** | | | | | | | |
| Apples | 28.4 | 84.1 | 0.86 | 0.45 | 121 | 32 | 830 |
| | | | | | | 40 | 1,435 |
| Apricots | 28.1 | 85.4 | 0.88 | 0.46 | 122 | — | — |
| Blackberries | 28.9 | 85.3 | 0.88 | 0.46 | 122 | — | — |
| Blueberries | 28.6 | 82.3 | 0.86 | 0.45 | 118 | — | — |
| Cantaloupes | 29 | 92.7 | 0.94 | 0.48 | 132 | 40 | 3,470 |
| | | | | | | 60 | 8,080 |
| Cherries | 26 | 83 | 0.87 | 0.45 | 120 | 32 | 1,250 |
| | | | | | | 60 | 12,000 |
| Cranberries | 27.3 | 87.4 | 0.90 | 0.46 | 124 | 32 | 650 |
| Currants | 30.2 | 84.7 | 0.88 | 0.45 | 120 | — | — |
| Gooseberries | 28.9 | 88.3 | 0.90 | 0.46 | 126 | — | — |
| Grapes | 26.3 | 81.7 | 0.86 | 0.44 | 116 | 35 | 830 |
| Honey Dew Melon | 20 | 92.6 | 0.94 | 0.48 | 132 | 32 | 1,300 |
| | | | | | | 60 | 8,500 |
| Peaches | 29.4 | 86.9 | 0.90 | 0.46 | 124 | 32 | 1,110 |
| | | | | | | 40 | 1,735 |
| Pears | 28.5 | 83.5 | 0.86 | 0.45 | 118 | 32 | 770 |
| Plums | 28 | 85.7 | 0.88 | 0.45 | 123 | — | — |
| Raspberries | 30.1 | 82 | 0.85 | 0.45 | 122 | 36 | 5,500 |
| | | | | | | 60 | 16,500 |
| Strawberries | 29.9 | 90 | 0.92 | 0.47 | 129 | 32 | 3,250 |
| | | | | | | 60 | 11,950 |
| Watermelons | 29.2 | 92.1 | 0.97 | 0.48 | 132 | — | — |

TABLE G—I (cont'd)

| PRODUCT | Average Freezing Point °F | Per cent Water | Sp ht, Btu/(lb.) (°F) | | Latent Heat of Fusion Btu/lb. | Heat of Respiration | |
|---|---|---|---|---|---|---|---|
| | | | Above Freezing | Below Freezing | | °F | Btu per (24 hr) ton |
| **MISCELLANEOUS** | | | | | | | |
| Butter | 30–0 | 15 | 0.64 | 0.34 | 15 | — | — |
| Cheese (American) | 17 | 60 | 0.64 | 0.36 | 79 | 40 | 4,680 |
| Cheese (Camembert) | 18 | 60 | 0.70 | 0.40 | 86 | 40 | 4,920 |
| Cheese (Limburger) | 19 | 55 | 0.70 | 0.40 | 86 | 40 | 4,920 |
| Cheese (Roquefort) | 3 | 55 | 0.65 | 0.32 | 79 | 45 | 4,000 |
| Cheese (Swiss) | 15 | 55 | 0.64 | 0.36 | 79 | 40 | 4,660 |
| Cream (40%) | 28 | 73 | 0.85 | 0.40 | 90 | — | — |
| Eggs (crated) | 27 | — | 0.76 | 0.40 | 100 | — | — |
| Eggs (frozen) | 27 | — | — | 0.41 | 100 | — | — |
| Honey | — | 18 | 0.35 | 0.26 | 26 | 40 | 1,420 |
| Hops | — | — | — | — | — | 35 | 1,500 |
| Maple sugar | — | 5 | 0.24 | 0.21 | 7 | 45 | 1,420 |
| Maple syrup | — | 36 | 0.49 | 0.31 | 52 | 45 | 1,420 |
| Milk | 31 | 87.5 | 0.93 | 0.49 | 124 | — | — |
| Nuts (dried) | — | 3–10 | 0.21–0.29 | 0.19–0.24 | 4.3–14 | 35 | 1,000 |
| Tobacco & Cigars | 25 | — | — | — | — | — | — |

# APPENDIX H

## Resistance of Grains and Seeds to Air Flow




## NOTES

This chart gives values for a loose fill (not packed) of clean, relatively dry grain.

For a loose fill of clean grain having high moisture content (in equilibrium with relative humidities exceeding 85 per cent), use only 80 per cent of the indicated pressure drop for a given rate of air flow.

Packing of the grain in a bin may cause 50 per cent higher resistance to air flow than the values shown.

When foreign material is mixed with grain no specific correction can be recommended. However, it should be noted that resistance to air flow is increased if the foreign material is finer than the grain, and resistance to air flow is decreased if the foreign material is coarser than the grain.

## FIGURE 1H
## Resistance of Grains and Seeds to Air Flow

# APPENDIX I
# Electrical Services

## TABLE I—I

### Allowable Current-Carrying Capacities of Insulated Copper and Aluminum Conductors in Amperes

| Size AWG or MCM | Not More Than Three Conductors in Raceway or Cable, or Direct Burial | | | | Single Conductors in Free Air | |
|---|---|---|---|---|---|---|
| | Rubber Insulation, Type R, RW, RU, RUW Type RH-RW in Wet Locations Thermoplastic Type T, TW | | Rubber Insulation, Type RH, RHW Type RH-RW in Dry Locations | | Weatherproof Insulation, Type WP | |
| | Copper | Aluminum | Copper | Aluminum | Copper | Aluminum |
| 14 | 15 | — | 15 | — | ** | ** |
| 12 | 20 | 15 | 20 | 15 | ** | ** |
| 10 | 30 | 25 | 30 | 25 | 55 | 45 |
| 8 | 40 | 30 | 45 | 40 | 70 | 55 |
| 6 | 55 | 40 | 65 | 50 | 100 | 80 |
| 4 | 70 | 55 | 85 | 65 | 130 | 100 |
| 3 | 80 | 65 | 100 | 75 | 150 | 115 |
| 2 | 95 | 75* | 115 | 90* | 175 | 135 |
| 1 | 110 | 85* | 130 | 100* | 205 | 160 |
| 0 | 125 | 100* | 150 | 120* | 235 | 185 |
| 00 | 145 | 115* | 175 | 135* | 275 | 215 |
| 000 | 165 | 130* | 200 | 155* | 320 | 250 |
| 0000 | 195 | 155* | 230 | 180* | 370 | 290 |
| 250 | 215 | 170 | 255 | 205 | 410 | 320 |
| 300 | 240 | 190 | 285 | 230 | 460 | 360 |
| 350 | 260 | 210 | 310 | 250 | 510 | 400 |
| 400 | 280 | 225 | 335 | 270 | 555 | 435 |
| 500 | 320 | 260 | 380 | 310 | 630 | 490 |
| 600 | 355 | 285 | 420 | 340 | 710 | 560 |
| 700 | 385 | 310 | 460 | 375 | 780 | 615 |
| 750 | 400 | 320 | 425 | 385 | 810 | 640 |

* For three-wire, single-phase service and sub-service circuits, the allowable current-carrying capacity of RH, RH-RW, RHH and RHW aluminium conductors shall be for sizes No. 2-100 amp, No. 1-110 amp, No. 1/0-125 amp, No. 2/0-150 amp, No. 3/0-170 amp and No. 4/0-200 amp.

** No. 6 is minimum permissible in overhead spans up to 50 ft. in length. For spans over 50 ft. in length, No. 8 is minimum permissible.

**NOTE TO TABLE I-I**

If bare conductors are used with insulated conductors, their allowable current-carrying capacity shall be limited to that permitted for insulated conductors of the same size.

## TABLE I—II

### Wire Sizes Required for Loads up to 400 Amperes at 230-240 Volts, Based on 2% Voltage Drop

| Load in Amperes | Length of Run in Feet | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 350 | 400 |
| 5 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 10 |
| 6 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 8 |
| 7 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 8 | 8 |
| 8 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 8 | 8 | 8 |
| 9 | 14 | 14 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 |
| 10 | 14 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 6 |
| 12 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 6 | 6 | 6 |
| 14 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 6 | 6 | 6 | 6 |
| 16 | 12 | 12 | 12 | 12 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 4 |
| 18 | 12 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 4 | 4 |
| 20 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 |
| 25 | 10 | 10 | 10 | 10 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 |
| 30 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 4 | 2 | 2 |
| 35 | 10** | 10** | 10** | 8 | 8 | 8 | 8 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 |
| 40 | 10** | 10** | 8 | 8 | 8 | 8 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 1 |
| 45 | 10*** | 10*** | 8* | 8* | 8* | 6 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 1 | 1 |
| 50 | 10*** | 8** | 8** | 8** | 6 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 1 | 1 | 0 |
| 60 | 8** | 8*** | 6* | 6* | 6* | 6* | 4 | 4 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 00 |
| 70 | 8** | 8*** | 6** | 6** | 6** | 4 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 00 | 00 |
| 80 | 6** | 6** | 6** | 6** | 4* | 4* | 4* | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 00 | 00 | 000 |
| 90 | 6*** | 6*** | 6*** | 4** | 4** | 4** | 4** | 2 | 2 | 1 | 1 | 0 | 0 | 00 | 00 | 000 | 000 |
| 100 | 6*** | 6*** | 4** | 4** | 4** | 4** | 2* | 2* | 1 | 1 | 0 | 0 | 00 | 00 | 000 | 000 | 0000 |

**NOTE TO TABLE I—II**

Conductors in overhead spans must be at least No. 10 for spans up to 50 feet and No. 8 for longer spans.

## TABLE I—II (cont'd)

| Load in Amperes | Length of Run in Feet | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 350 | 400 |
| 115 | 4*** | 4*** | 4*** | 4*** | 2* | 2* | 2* | 2* | 1* | 0 | 00 | 00 | 00 | 000 | 000 | 0000 | 250M † |
| 130 | 4*** | 4*** | 4*** | 2** | 2** | 2** | 2** | 1* | 0* | 0* | 00 | 000 | 000 | 000 | 0000 | 0000 | 250M |
| 145 | 2*** | 2*** | 2*** | 2*** | 2*** | 2*** | 1** | 0* | 0* | 00 | 00 | 000 | 0000 | 0000 | 0000 | 250M | 300M |
| 160 | 2*** | 2*** | 2*** | 2*** | 2*** | 1** | 1** | 0** | 00* | 00* | 000 | 000 | 0000 | 0000 | 250M | 300M | 300M |
| 180 | 1*** | 1*** | 1*** | 1*** | 1*** | 1*** | 1*** | 0** | 00** | 000* | 000* | 0000 | 0000 | 250M | 300M | 300M | 350M |
| 200 | 1*** | 1*** | 1*** | 1*** | 1*** | 1*** | 0*** | 00** | 000* | 000* | 0000* | 0000* | 250M | 300M | 300M | 350M | 400M |
| 225 | 0*** | 0*** | 0*** | 0*** | 0*** | 0*** | 0*** | 00** | 000** | 0000* | 0000* | 250M* | 300M | 300M | 350M | 400M | 500M |
| 250 | 00*** | 00*** | 00*** | 00*** | 00*** | 00*** | 00*** | 000** | 0000** | 0000** | 250M* | 300M* | 300M* | 350M | 350M | 400M | 500M |
| 275 | 00*** | 00*** | 00*** | 00*** | 00*** | 00*** | 00*** | 000*** | 0000** | 250M** | 300M* | 300M* | 350M* | 350M* | 400M | 500M | |
| 300 | 000*** | 000*** | 000*** | 000*** | 000*** | 000*** | 000*** | 0000** | 250M** | 250M** | 300M** | 350M* | 350M* | 400M* | 500M | 500M | |
| 325 | 0000*** | 0000*** | 0000*** | 0000*** | 0000*** | 0000*** | 0000*** | 0000*** | 250M** | 300M** | 300M** | 350M** | 400M* | 500M* | 500M* | | |
| 350 | 0000*** | 0000*** | 0000*** | 0000*** | 0000*** | 0000*** | 0000*** | 0000*** | 250M*** | 300M** | 350M** | 400M** | 400M** | 500M* | 500M* | | |
| 375 | 250M*** | 250M*** | 250M*** | 250M*** | 250M*** | 250M*** | 250M*** | 250M*** | 300M** | 350M** | 350M** | 400M** | 500M** | 500M** | | | |
| 400 | 250M*** | 250M*** | 250M*** | 250M*** | 250M*** | 250M*** | 250M*** | 250M*** | 300M*** | 350M** | 400M** | 500M** | 500M** | | | | |

* Type RH or RHW in cable or raceway; all types in air. For other types of wire in cable or raceway refer to Table I-I for minimum size permissible.

** Weatherproof or Type TW in air. For wires in cable or raceway refer to Table I-I for minimum size permissible.

*** Weatherproof wire in air. For all other conditions refer to Table I-I for minimum size permissible.

†M = thousand circular mils.

### NOTE TO TABLE I—II

Conductors in overhead spans must be at least No. 10 for spans up to 50 feet and No. 8 for longer spans.

## TABLE I—III

### Wire Sizes Required for Loads up to 200 Amperes at 115-120 Volts, Based on 2% Voltage Drop

| Load in Amperes | Length of Run in Feet | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 350 | 400 |
| 5 | 14 | 14 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 6 | 6 |
| 6 | 14 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 6 | 6 | 6 |
| 7 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 6 | 6 | 6 | 6 |
| 8 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 4 |
| 9 | 14 | 14 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 |
| 10 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 |
| 12 | 14 | 12 | 12 | 10 | 10 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 |
| 14 | 14 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 |
| 16 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 |
| 18 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 |
| 20 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 1 |
| 25 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 1 | 1 | 0 |
| 30 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 2 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 00 |
| 35 | 10** | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 00 | 00 |
| 40 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 00 | 00 | 000 |
| 45 | 8* | 8* | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 00 | 00 | 000 | 000 |
| 50 | 8** | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 00 | 00 | 000 | 000 | 0000 |

**NOTE TO TABLE I—III**

Conductors in overhead spans must be at least No. 10 for spans up to 50 feet and No. 8 for longer spans.

## TABLE I—III (cont'd)

| Load in Amperes | Length of Run in Feet | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 125 | 150 | 175 | 200 | 225 | 250 | 275 | 300 | 350 | 400 |
| 60 | 6* | 6* | 4 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 0 | 00 | 00 | 000 | 000 | 000 | 0000 | 250M† |
| 70 | 6** | 6** | 4 | 4 | 2 | 2 | 2 | 2 | 1 | 0 | 00 | 00 | 000 | 000 | 0000 | 0000 | 250M | 300M |
| 80 | 6** | 4* | 4* | 2 | 2 | 2 | 2 | 1 | 0 | 00 | 000 | 000 | 000 | 0000 | 0000 | 250M | 300M | 300M |
| 90 | 6*** | 4** | 4** | 2 | 2 | 2 | 1 | 1 | 0 | 00 | 000 | 000 | 0000 | 0000 | 250M | 250M | 300M | 350M |
| 100 | 4** | 4** | 2* | 2* | 2* | 1 | 1 | 0 | 00 | 000 | 000 | 0000 | 0000 | 250M | 300M | 300M | 350M | 400M |
| 115 | 4*** | 2* | 2* | 2* | 1 | 0 | 0 | 0 | 00 | 000 | 0000 | 0000 | 250M | 300M | 300M | 350M | 400M | 500M |
| 130 | 4*** | 2** | 2** | 1* | 1* | 0 | 00 | 00 | 000 | 0000 | 0000 | 250M | 300M | 300M | 350M | 350M | 500M | 500M |
| 145 | 4*** | 2*** | 1** | 1** | 0* | 00 | 00 | 00 | 0000 | 0000 | 250M | 300M | 350M | 350M | 400M | 400M | 500M | |
| 160 | 4*** | 2*** | 1** | 0** | 0** | 00 | 00 | 000 | 0000 | 250M | 300M | 300M | 350M | 400M | 400M | 500M | 500M | |
| 180 | 2*** | 2*** | 1*** | 0** | 00** | 00** | 000* | 000* | 0000 | 250M | 300M | 350M | 400M | 500M | 500M | 500M | | |
| 200 | 2*** | 1*** | 0*** | 00** | 00** | 000* | 000* | 0000* | 250M | 300M | 350M | 400M | 500M | 500M | 500M | | | |

* Type RH or RHW in cable or raceway; all types in air. For other types of wire in cable or raceway refer to Table I-I for minimum size permissible.

** Weatherproof or Type TW in air. For wires in cable or raceway refer to Table I-I for minimum size permissible.

*** Weatherproof wire in air. For all other conditions refer to Table I-I for minimum size permissible.

M = thousand circular mils.

### NOTE TO TABLE I—III

Conductors in overhead spans must be at least No. 10 for spans up to 50 feet and No. 8 for longer spans.

# APPENDIX J
# Water Supply

## TABLE J—I
## Water Heater Requirements

| Size of Herd | Type of Milker | Type of Barn | Storage Capacity | Water Heater Heating Elements | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| 20 or less | Pail | Stanchion | 22 gal. | 1000 | 1000 |
| 20 to 40 | " | " | 40 gal. | 1500 | 1500 |
| 20 to 40 | Pipeline | " | 40 gal. | 1000 | 3000* |
| 20 to 40 | " | " | 40 gal. | 1500 | 4500** |
| 20 to 40 | " | Milking Parlor | 40 gal. | 1500 | 4500** |
| 40 to 60 | " | Stanchion | 60 gal. | 1500 | 4500** |
| 40 to 60 | " | Milking Parlor | 60 gal. | 1500 | 4500** |
| Over 60 Cows | " | Milking Parlor | 2–40 gal. | 1–1500<br>1–1500 | 4500**<br>4500** |

*New Canadian Standard Electric Water Heater.

**Water heaters equipped with high recovery rate units should be so wired as to prevent operation of both elements at the same time.

## TABLE J—II
## Nominal Sizes of Steel Distribution Pipes

| Gallons Per Minute | Length of Pipe | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 25′ | 50′ | 100′ | 200′ | 300′ | 400′ | 500′ | 700′ | 1000′ | 1500′ |
| 5 | ½″ | ¾″ | ¾″ | 1″ | 1″ | 1″ | 1¼″ | 1¼″ | 1¼″ | 1½″ |
| 10 | ¾″ | 1″ | 1″ | 1¼″ | 1¼″ | 1¼″ | 1½″ | 1½″ | 1½″ | 2″ |
| 15 | 1″ | 1″ | 1¼″ | 1¼″ | 1½″ | 1½″ | 2″ | 2″ | 2″ | 2½″ |
| 20 | 1″ | 1¼″ | 1¼″ | 1½″ | 2″ | 2″ | 2″ | 2½″ | 2½″ | 2½″ |
| 30 | 1¼″ | 1¼″ | 1½″ | 2″ | 2″ | 2½″ | 2½″ | 2½″ | 3″ | 3″ |

### NOTES TO TABLE J-II

For plastic pipe use this Table for sizes up to 1 in. If steel pipe size required is over 1 in. use next smaller size of plastic pipe. For copper pipe use size given in Table for Steel.

Pipe sizes are based on pressure drop of 5 lb./sq. in.

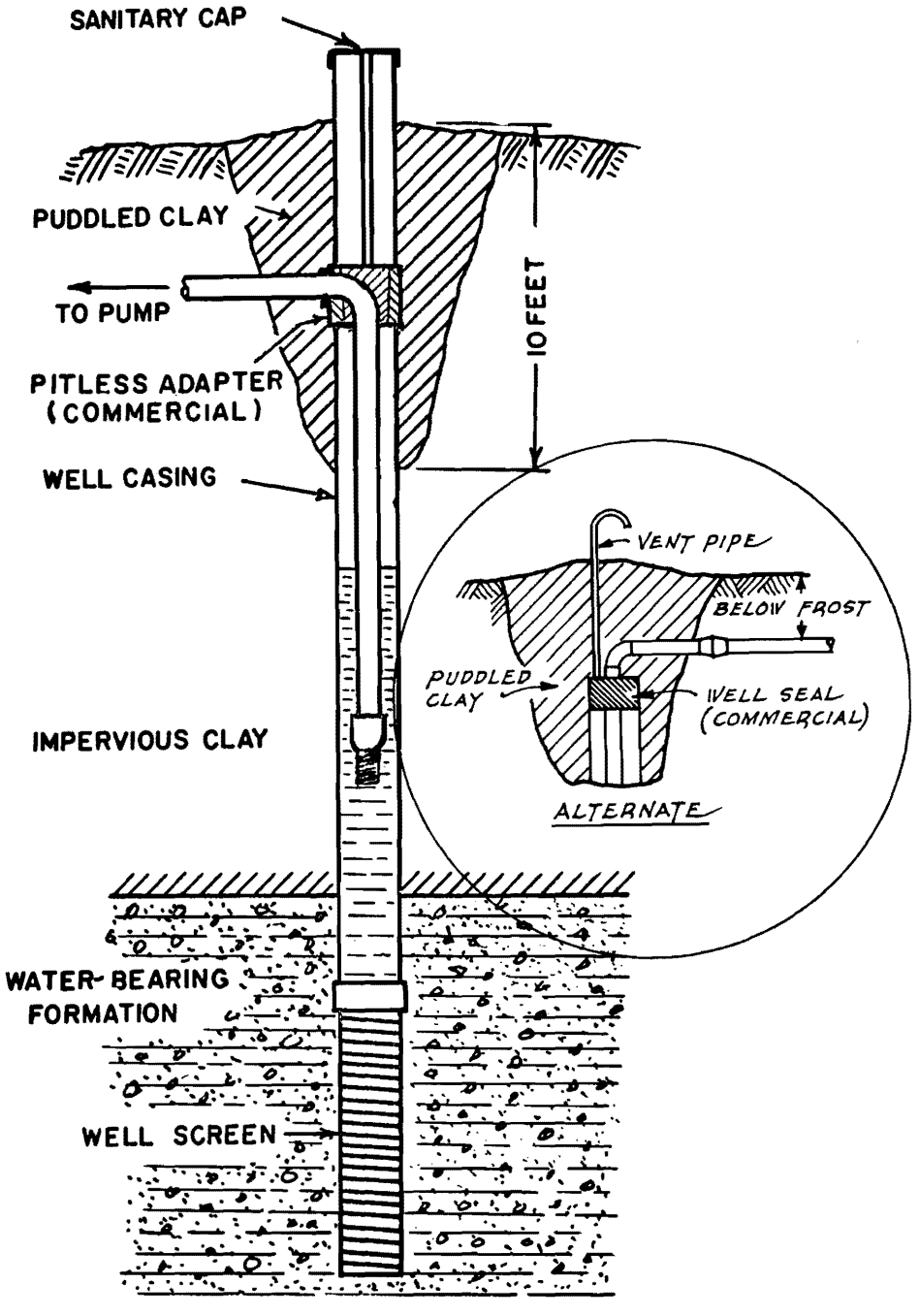



FIGURE 1J
Drilled-Well Construction

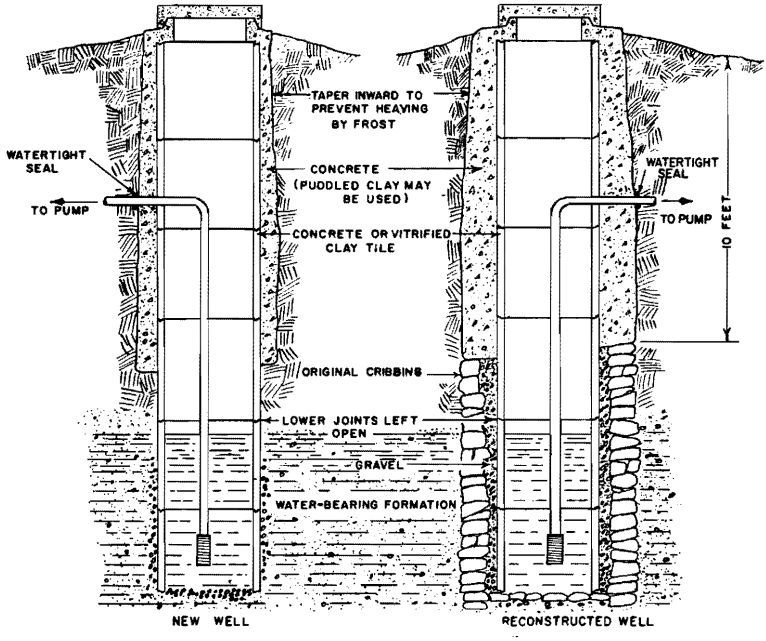



**FIGURE 2J**
**Dug-Well Construction**

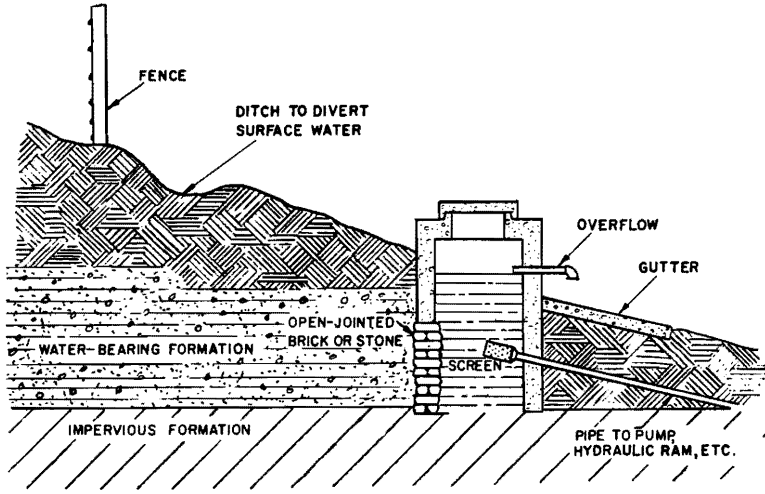



**FIGURE 3J**
**Spring Protection**

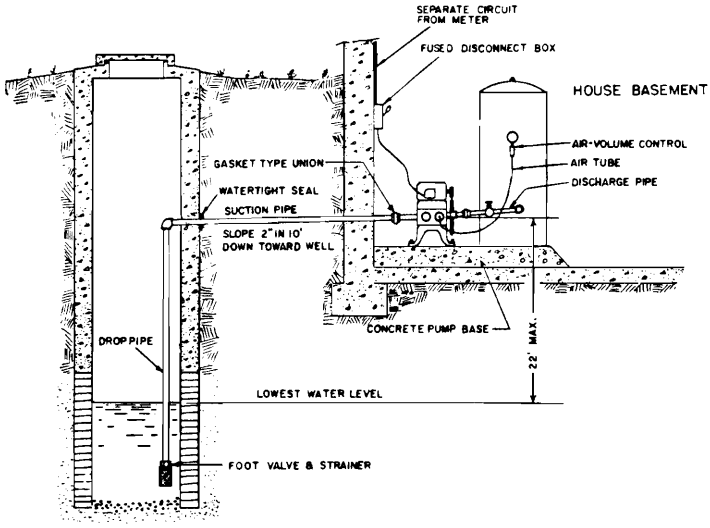



FIGURE 4J
Shallow-Well Pump Installation

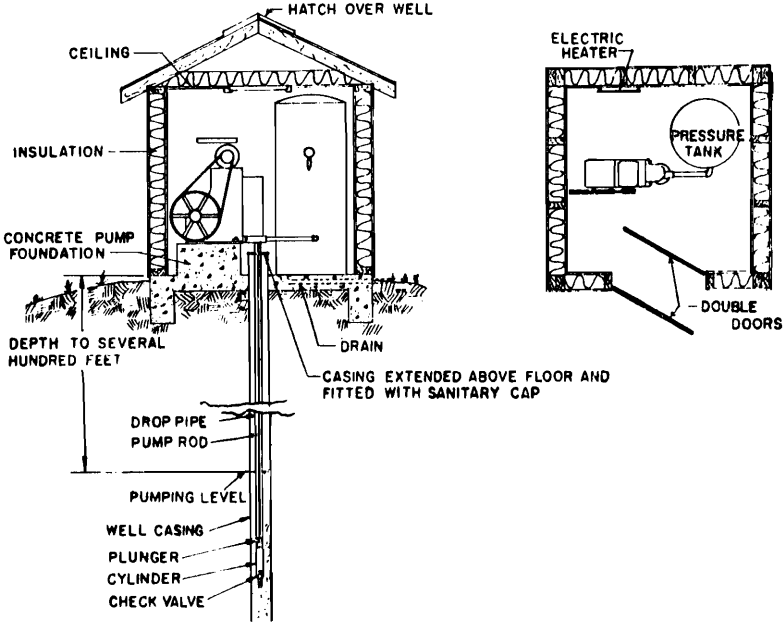



FIGURE 5J
Deep-Well Reciprocating Pump Installation

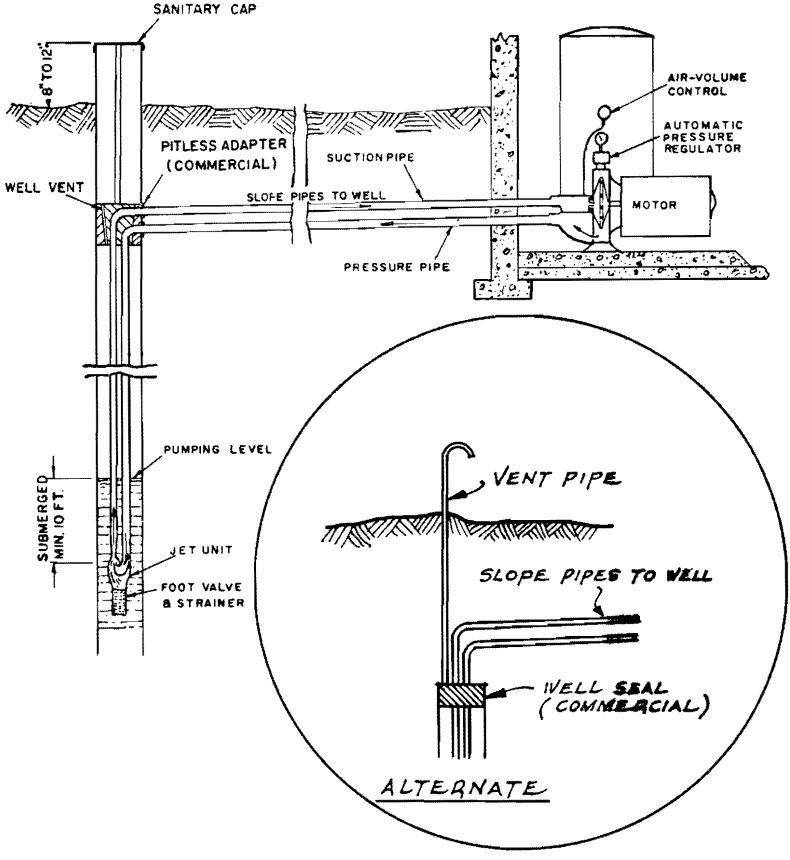



**FIGURE 6J**
**Deep-Well Centrifugal-Jet Pump Installation**

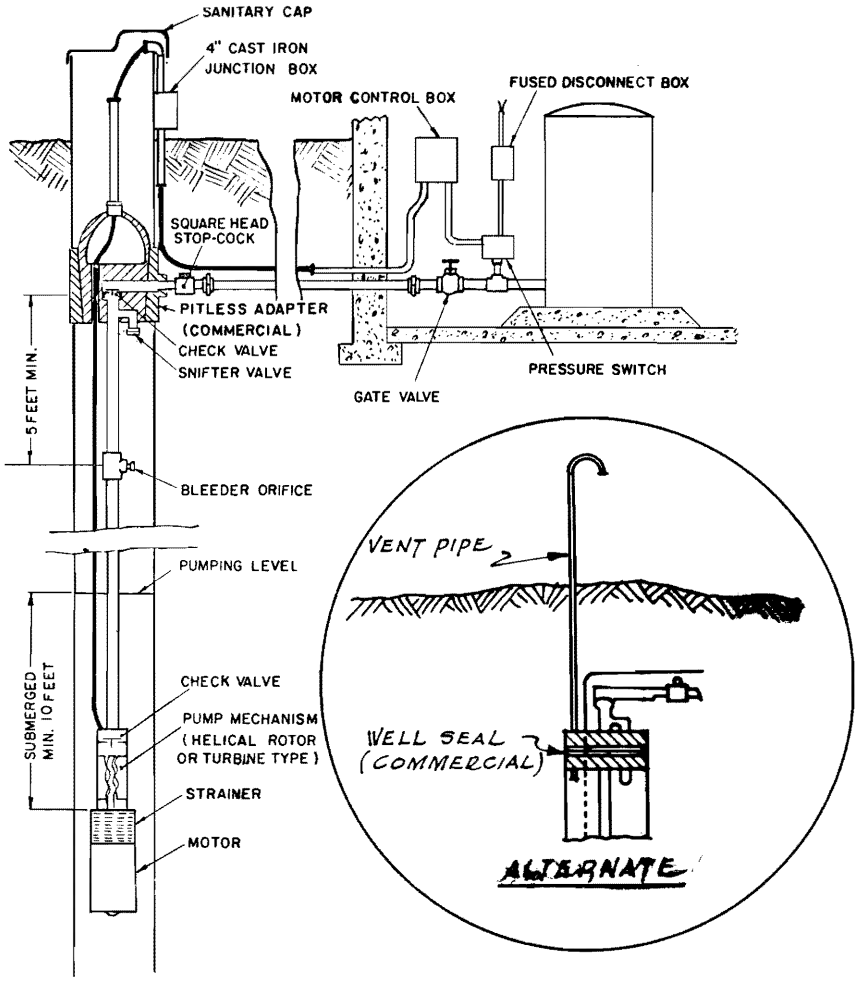



**FIGURE 7J**
**Deep-Well Submersible Pump Installation**

# APPENDIX K
# Waste Disposal

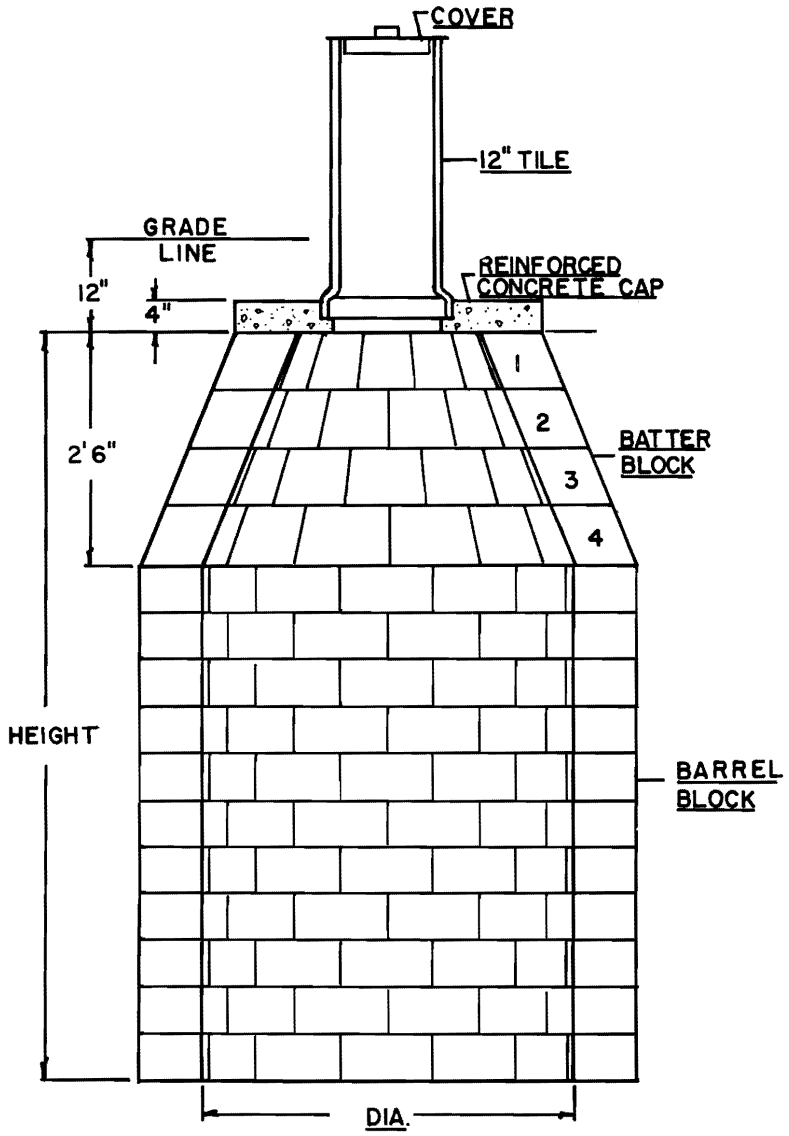



FIGURE 1K
Concrete Block Disposal Pit

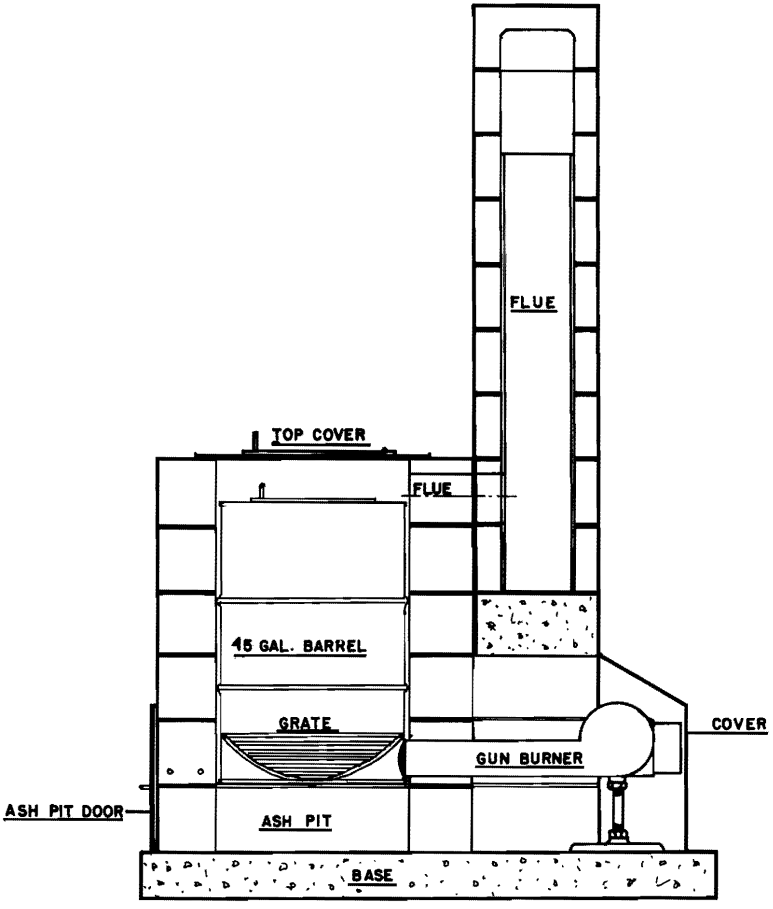



FIGURE 2K
Cross Section of Incinerator

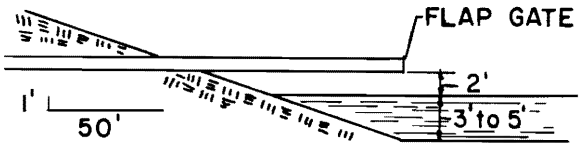



FIGURE 3K
Free-Loading Inlet

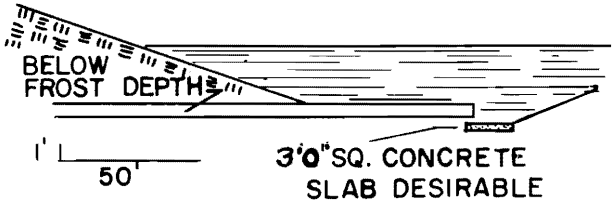



FIGURE 4K
Centre-Loading Inlet

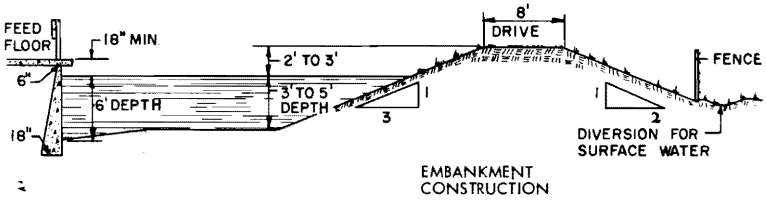



FIGURE 5K
Direct Loading From Feedlot

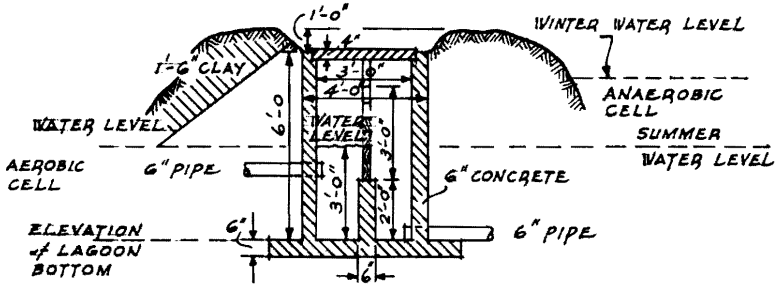



FIGURE 6K
Outlet Structure (Single Cell Lagoon)
or
Control Structure (Multiple Cell Lagoon)

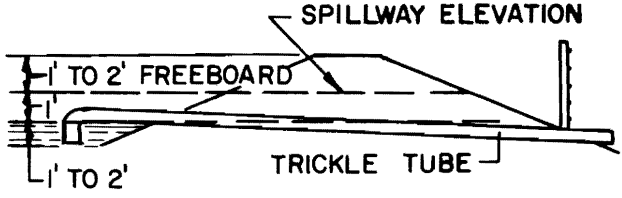



FIGURE 7K
Alternate Outlet

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OTTAWA 7, CANADA