CANADIAN CODE FOR FARM BUILDINGS

(FARM BUILDING STANDARDS)

1970

Issued by the

ASSOCIATE COMMITTEE ON THE NATIONAL BUILDING CODE

NATIONAL RESEARCH COUNCIL OF CANADA

OTTAWA

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FOREWORD

Canadian Code for Farm Buildings, 1970 has been developed as a guide for those interested in the design, construction, remodelling and evaluation of a wide variety of farm buildings, excluding the farm dwelling.

It provides general recommendations and detailed specifications 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 by a recognized testing agency or through experience with good engineering practice.

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

This Code covers three main parts:

1. **Basic standards**, which deals primarily with specifications related to design and construction of new farm buildings, and to the alteration of existing farm buildings.

   The specifications refer primarily to structural sufficiency, fire prevention, safety, 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.

2. **Good practice and performance**, which relates primarily to the functional requirements of farm buildings and to good construction practices.

   The recommendations and specifications are optimum, consistent with good management practices to permit efficient production and storage and economical construction.

3. **Appendixes**, which include technical data and information as reference material for the various sections of the Code.

The work of preparing the Code has been carried out through a Committee, consisting of engineers and specialists from universities, government, related industries and services.

It is intended that the Code represent contemporary building practice in Canada.

C. G. E. Downing,
Chairman,
Standing Committee on
Farm Building Standards
of the Associate Committee on the
National Building Code.

ACKNOWLEDGEMENTS

Throughout this text, many documents are referred to and pertinent information has been reprinted from some reports. Reference to the source material has been made; if some references have been inadvertently omitted, apologies are here recorded.

The publications from which information has been reprinted are listed in the Bibliography which follows Part 2 of this Code. Also included in the Bibliography are other documents that may be of help and interest to the user.

The co-operation received from many persons and organizations in the preparation of this document is gratefully acknowledged by the Standing Committee on Farm Building Standards of the Associate Committee on the National Building Code.

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SUBSECTION 1.1.1. GENERAL

The requirements of Section 1.1. apply to the design and construction of new farm buildings and to the alterations of existing farm buildings.

1.1.1.1. 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.

1.1.1.2. Design

Farm buildings should be designed in accordance with the National Building Code of Canada 1970 unless stated otherwise.

1.1.1.2. Conditions

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

(a) All climatic loads that may be applied to them during the expected life of the building (in accordance with Supplement No. 1, Climate, to the National Building Code of Canada 1970).

(b) All loads due to the intended use of the building that may be applied to them during the period of that use (see Sentence 1.1.2.1.(2)).

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

(d) All loads due to the materials of construction (see Sentence 1.1.2.1.(1)).

(e) 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.

1.1.1.3. Materials and Building Components

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

(1) tests that simulates anticipated service conditions, or

(2) recognized engineering principles.

1.1.1.4. Construction Methods

Construction methods should conform to good practice.

1.1.1.5. 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) sufficient detail to enable the loads due to materials of construction incorporated in the building to be determined, 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.

1.1.1.6. Construction Safety Measures

Construction safety measures should conform to the Canadian Code for Construction Safety, 1970, issued by the Associate Committee on the National Building Code of Canada where applicable.

SUBSECTION 1.1.2. STRUCTURAL LOADS AND PROCEDURES

1.1.2.1. Loads

(1) Loads due to materials of construction

The minimum design load due to materials of construction incorporated in farm building tributary to a structural member is:

(a) the weight of the member itself,

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

TABLE I

MINIMUM DESIGN FLOOR AND SUSPENDED LOADS DUE TO USE

Use of Area of Floor	Design Live Load, psf
Cattle	
tie stall barns	70
loose housing (holding area)	80
milking parlours	70
milkrooms or milkhouses	50*
Sheep	30
Swine	
solid floors	40
Horses	100
Chickens	
floor-housing	40**
cages	
floor supported**	
suspended	
– full stair step double deck (no dropping boards)	75 lb/ft of cage row***
– modified stair step double deck (with dropping boards)	100 lb/ft of cage row***
– modified stair step triple deck (with dropping boards)	165 lb/ft of cage row***
Turkeys	40
Product storage	****
Machinery	*****
Greenhouses	50
Maintenance shops	70 (See Subclause 1.1.2.1. (2) (c) (ii)

Notes to Table I:

* Floor constructions under bulk tanks should be designed according to the weight of the tank plus contents.

** Where a space is provided for the accumulation of manure, the design load should be based on 65 psf per foot of depth. Design loads for floor supported cages require special consideration based on supported intervals and weights.

*** Based on 4 row (double deck) or 6 row (triple deck) with 2 birds per 8 in. cage, or 3 birds per 12 in. cage, and 2 in. of manure accumulated dropping boards under upper cages.

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

***** See Clause 1.1.2.1.(2)(c), Loads for Vehicle Storage.

(c) the estimated weight of possible future additions.

(2) Loads due to use

(a) The minimum design load on any area of floor due to the use of the area is listed in Table I.

(b) For loads for livestock on slotted floors and penned in groups, see Table II.

(c) Loads for vehicle storage

(i) Vehicle storage (uniformly distributed): The minimum design load on an area of floor, used for farm machinery 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 lb where weight restriction includes effect of mounted equipment) then the design load should be 200 psf.

(ii) Vehicle storage (concentrated): In the absence of specific information, the minimum design loads due to probable concentrations of loads resulting from use of an area of floor is as follows:

(1) For tractors and implements: 5000 lb per wheel.

(2) For loaded trucks not exceeding 20,000 lb gross vehicle weight (GVW): 8000 lb per wheel.

(3) For loaded trucks exceeding 20,000 lb GVW: 12,000 lb per wheel.

(iii) Vehicle loading and processing: In cases where the area (minimal traffic or driveway) is to serve as a place for loading, unloading or processing, minimum design loads for such areas should be increased by 50 per cent to allow for impact or vibrations of the piece of machinery or equipment.

TABLE II

FLOOR LOADS FOR GROUPS OF ANIMALS ON SLOTTED FLOORS

Livestock	Live Loads for Design of a Floor Slat Unit, lb per foot of slat	Live Distributed Loads for Design of Slat Supports, lb per sq ft of floor
Dairy cows and heifers	300	100
Beef cows and feeders	250	100
Dairy and beef calves to 300 lb	150	50
Sheep	120	50
Swine		
Weaners to 50 lb*	50	35
Feeders to 200 lb	100	50
Sows to 500 lb**	170	70

Notes to Table II:

* An alternate requirement, which may or may not dictate design, is one concentrated load of 220 lb (man + pig), so located first to give maximum moment, then maximum shear, in slats and slat supports.

** Slotted floors in farrowing pens should be designed for a single concentrated load of 250 lb located first to give maximum moment, then maximum shear, in slats and slat supports.

(d) Loads imposed by corn and grass

(i) Lateral pressure: Cylindrical silos with friction coefficients similar to concrete for corn or grass silage not exceeding 70 per cent moisture (wet basis) should be designed for lateral pressure as determined by the formula to follow. This formula is not intended for design of grain storage cylinders, but silos designed by this formula are reasonably safe for normal shelled corn pressures.

$$L = 100 + 1.92\ hd^{0.55}$$

where L = lateral pressure, psf
h = vertical distance from top of silo wall, ft
d = silo diameter, ft.

(ii) For design of circumferential reinforcement in concrete silos, the allowable unit stresses should not be increased as permitted in low human occupancy buildings, under Clause 1.1.2.2.(1)(b).

(iii) Vertical wall loads: Cylindrical silo walls for corn, grass or legume silage should be designed to support vertical loads imposed by the dead weight of the walls and roof plus live load resulting from the vertical friction imposed by the silage. For concrete silos, this friction load may be approximated by assuming that the wall supports the weight of silage above a circular cone with base defined by the floor of the silo and height of 3.2 times the silo diameter.

(e) 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 A. Physical properties of stored crops are given in Table A-I.

(f) Loads imposed by stored potatoes

(i) Information relating to loads imposed by stored potatoes in deep bins is given in Figure 2-A, Appendix A.

(ii) The minimum design load for bin walls should include the combined effect of vertical and horizontal loads as given in Figure 2-A, Appendix A.

(iii) If the storage is located near a railroad mainline or a main highway, the minimum design load should be increased by 15 per cent to allow for vibration.

(3) Loads due to snow

Loads due to snow should be in accordance with Articles 4.1.5.1. to 4.1.5.4. of Section 4.1, Structural Loads and Procedures, of the National Building Code of Canada, 1970.

(4) Loads due to wind

Loads due to wind should be in accordance with Articles 4.1.6.1. to 4.1.6.3. of Section 4.1, Structural Loads and Procedures, of the National Building Code of Canada, 1970.

(5) Loads due to rain

Loads due to rain should be in accordance with Article 4.1.5.5. of Section 4.1, Structural Loads and Procedures, of the National Building Code of Canada, 1970.

(6) Loads due to earthquakes

Farm buildings for low human occupancy need not be designed to withstand loads due to earthquakes.

1.1.2.2. Design Procedures

(1) Allowable stresses

The following clauses are designed to permit farm building design with a reduced over-all safety factor in recognition of low risk of human life and low value of contents or low risk to loss of contents.

(a) *For purposes of structural design, low human occupancy farm building means a building or major portion having an occupant density no greater than one person per 500 sq ft during normal periods of use of 4 hr or longer.* All other buildings should be considered as high human occupancy. This includes such buildings as processing rooms, workshops, auction or show arenas, or other areas likely to be occupied by several persons over extended periods.

(b) For the structural design of low human occupancy farm buildings, the allowable unit stresses in tension, compression, bending, and shear as set forth in Tables V(a), (b) and (c) and the National Building Code, 1970, may be increased by 25 per cent except as provided for in Subclause 1.1.2.1.(2) (d) (ii).

(c) Increases in allowable stresses for low human occupancy farm buildings in accordance with Clause 1.1.2.2.(1) (b) may be applied cumulatively with other modification factors given in the National Building Code of Canada, 1970.

(2) Bracing for wind load

Buildings should be designed for loads determined in Sentence 1.1.2.1. (4). Supports, bracing, diaphragms and ties should be installed where required to adequately carry wind forces to the foundation and to prevent collapse, uplift, overturning and racking (horizontal shear).

(3) Connections

Connections should be designed as provided for in the National Building Code to carry any combination of live and dead loads provided for in the design. Increases in allowable stresses may be used in accordance with Sentence 1.1.2.2. (1). Where design procedures are not covered in the National Building Code of Canada, 1970, standard engineering design procedures should be used.

(4) Deflections

(a) 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.

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

(c) 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.

SUBSECTION 1.1.3. FOUNDATIONS

1.1.3.1. 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.

1.1.3.1.

(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 bearing or frictional resistance. Design using frictional resistance should be in accordance with Articles 4.2.5.4. and 4.2.5.5. of the National Building Code of Canada, 1970.

1.1.3.2. Footings

(1) General

(a) Except as permitted in Sentence (d) below, footings should be provided under foundation walls, columns, piers, and poles to distribute the loads in accordance with the allowable bearing values of the supporting material in Table E-I, Appendix E.

(b) 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 E-I, Appendix E, increased at the rate of 20 per cent for each foot increase in depth but not more than 200 per cent.

(c) 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 Clauses (a) and (b) above.

(d) Footings may be omitted if the safe bearing capacity of the soil or rock is not exceeded, and if the foundation is otherwise prevented from overturning.

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

(f) 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) Concrete footings for concrete, masonry or stone walls

(a) General

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

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

(b) Plain footings

(i) The minimum thickness of plain footings should be the minimum thickness of foundation walls prescribed in Clause 1.1.3.3.(1)(c).

(ii) 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 1.1.3.3.(1)(c).

(c) Steel reinforced footings

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

(3) Concrete footings for columns and poles

(a) Column footings should be of sufficient size to carry the concentrated loads they must support.

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

(c) 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.

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

(e) Backfill around poles should be tamped earth or placed concrete.

(4) Wood footings for wood or metal walls, columns, posts or poles

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

(b) Wood footings should be designed so as not to exceed the allowable unit stresses specified in Article 1.1.4.2. for the grade and species used.

(c) Wood footings should be treated in accordance with Subsection 2.3.5.

1.1.3.3. Foundation Walls

(1) Concrete and unit masonry foundation walls

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

(b) Except as provided for in Sentence (c) below, the minimum thickness of foundation walls should be 8 in.

(c) Minimum thicknesses

(i) 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.

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

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

(2) the walls are of concrete and extend more than 7 ft into the ground (for masonry walls see Clause 1.1.5.2.(1)(d)),

(3) the total height of foundation and superstructure bearing walls is more than 24 ft but less than 35 ft.

(iii) 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.

(d) Foundation walls should extend at least 8 in. above ground. All exterior surfaces of basement or cellar walls below grade should be dampproofed below grade by:

(i) 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.

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

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

(2) Wood-frame foundation walls

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

(b) All horizontal and vertical framing, and plywood or lumber sheathing below grade and to a minimum height of 8 in. above grade, should be treated in accordance with Subsection 2.3.5., Wood Preservation.

(3) Backfilling

Backfilling should be placed carefully against the foundation walls to avoid damaging the walls or injuring any dampproofing, 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.

1.1.3.4. Concrete Grade Beam Foundations

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

(2) Piers

(a) 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.

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

(c) Piers should extend below frost line to a firm bearing surface.

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

(3) 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.

1.1.3.5. 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 2.3.5., Wood Preservation, below grade and to a minimum height of 8 in. above grade.

1.1.3.6. Concrete Slabs-on-grade

(1) Slabs-on-grade (with perimeter foundation walls)

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

(b) The tops of slabs should be at least 4 in. above exterior finish grade.

(c) Uniformly distributed reinforcement for slabs-on-grade should weigh not less than 40 lb per 100 square feet.

(d) 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) Slabs-on-grade (without perimeter foundation walls)

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

(b) The tops of slabs should be at least 8 in. above exterior finish grade.

(c) 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.

1.1.3.7. Wood Sills and Skirting

(1) Wood sills

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

(b) Wood sills on or below grade should be treated in accordance with Subsection 2.3.5., Wood Preservation.

(2) Wood skirting

Lumber or plywood skirting should be treated in accordance with Subsection 2.3.5. below grade and to a minimum height of 8 in. above grade.

SUBSECTION 1.1.4. WOOD

1.1.4.1. General

(1) Except as otherwise provided for in this Subsection, the design of farm buildings or structural elements made from wood or wood products should be in accordance with the relevant clauses in the Chapter on Wood in NBC Supplement No. 4, Canadian Structural Design Manual, 1970.

(2) Full inch dimensions, stated herein, are nominal. Actual sizes should be in accordance with CSA Specification O141-1965, Softwood Lumber.

1.1.4.2. Allowable unit stresses

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

TABLE III
SPECIES GROUP

Group	Species
A	Douglas Fir, Western Larch
B	Pacific Coast Hemlock Fir (Amabilis and Grandis only)
C	Pacific Coast Yellow Cedar Tamarack Jack Pine Eastern Hemlock
D	Balsam Fir Pine (Lodgepole and Ponderosa only) Spruce (all species)
E	Western Red Cedar Red Pine Western White Pine White Pine
F	Poplar (Aspen, Large-toothed Aspen, and Balsam only)

(2) (a) All 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. Grading rules for sawn lumber are given in Table IV.

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

1.1.4.2.

(3) (a) Graded lumber used in high human occupancy farm buildings may be assigned allowable unit stresses listed in Tables V(a), (b), and (c) under "load sharing uses," provided the framing elements are spaced at 24 in. or less.

(b) Graded lumber used in low human occupancy farm buildings may be assigned allowable unit stresses listed in Tables V(a), (b), and (c) under "load sharing uses," provided the framing elements are spaced at 48 in. or less.

(c) Graded lumber used in other than load sharing systems may be assigned allowable unit stresses listed in Tables V(a), (b), and (c) under "single member uses."

"Load sharing system" means a construction composed of three or more essentially parallel members so arranged or connected by continuous decking, bridging or stiffeners such that excessive deflection in one of the members causes additional load transfer to adjacent members.

(4) Reference should be made to CSA Specification O86-1970, "Code of Recommended Practice for Engineering Design in Timber," as contained in NBC Supplement No. 4, Canadian Structural Design Manual, 1970, for further information on modifications of allowable unit stresses. For low human occupancy farm buildings, these modifications are cumulative with those given in Clause 1.1.2.2.(1)(b).

TABLE IV
GRADING RULES FOR SAWN LUMBER

SPECIES GROUP	SPECIES TO WHICH EACH GRADING RULE APPLIES						
	British Columbia Lumber Manufacturers Association (BCLMA) Grading and Dressing Rules, No. 59, revised August, 1966.	West Coast Lumber Inspection Bureau (WCLIB) Standard Grading Rules No. 15, revised to June, 1967.	Western Wood Products Association (WWPA) Standard Grading Rules, revised to October, 1966.	Eastern Spruce Grading Committee (ESGC) Standard Grading Rules, revised to September, 1964.	Canadian Lumbermen's Association (CLA) Standard Grading Rules, revised to August, 1967.	Eastern Pine Grading Committee (EPGC) Rules for White and Red Pine, revised to August, 1962.	Northeastern Lumber Manufacturers Association (NELMA) Standard Grading Rules for Northern White Pine, revised to September, 1962.
A	Douglas fir Western larch	Douglas fir	Douglas fir Western larch				
B	Pacific Coast Hemlock	Pacific Coast Hemlock	Pacific Coast Hemlock Amabilis fir Grand fir				
C	Pacific Coast Yellow Cedar		Jack Pine	Eastern Hemlock Tamarack Jack Pine			
D	Sitka Spruce	Sitka Spruce	Lodgepole Pine Ponderosa Pine Spruces (except Sitka)	Balsam fir Spruces (except Sitka & Engelmann)			
E	Western Red Cedar	Western Red Cedar			White Pine Red Pine	White Pine Red Pine	White Pine Red Pine
F				Poplars (Aspen, Large-toothed Aspen, and Balsam only.)			

Note to Table IV:

Lumber grades should be specified by intended end use (e.g. light framing, joist and plank, beam and stringer, post and timber), as well as species and grade. Designers are advised to check the availability of grade, species, and size of members required before specifying.

TABLE V(a)

ALLOWABLE UNIT STRESSES FOR LIGHT FRAMING SIZES OF SAWN LUMBER, PSI

(Thickness: 2 to 4 in.; Width: 3* or 4 in.; Dry Service Conditions; Normal Duration of Load)

GRADING RULE	GRADE	Species Group	BENDING				COMPRESSION				Tension Parallel to Grain		Modulus of Elasticity
			Stress at Extreme Fibre		Longitudinal Shear		Parallel to Grain		Perpendicular to Grain				
			Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	
BCLMA WCLIB WWPA	Select Structural #	A	1750	1950	130	145	1300	1400	460	505	1200	1300	1,730,000
		B	1300	1450	105	115	1050	1150	235	255	850	950	1,450,000
	Select Merchantable	C	– –	1350	– –	105	– –	1250	– –	335	– –	– –	1,260,000
		D	– –	1050	– –	75	– –	1050	– –	245	– –	– –	1,210,000
		E	– –	1000	– –	85	– –	1150	– –	235	– –	– –	1,130,000
	Construction	A	– –	950	– –	110	– –	1250	– –	460	– –	– –	1,380,000
		B	– –	700	– –	90	– –	1000	– –	235	– –	– –	1,160,000
		C	– –	850	– –	105	– –	1050	– –	335	– –	– –	1,000,000
		D	– –	650	– –	75	– –	900	– –	245	– –	– –	970,000
		E	– –	650	– –	85	– –	950	– –	235	– –	– –	900,000
	Standard	A	– –	550	– –	85	– –	1000	– –	460	– –	– –	1,380,000
		B	– –	400	– –	65	– –	800	– –	235	– –	– –	1,160,000
		C	– –	500	– –	80	– –	850	– –	335	– –	– –	1,000,000
		D	– –	400	– –	55	– –	700	– –	245	– –	– –	970,000
		E	– –	350	– –	65	– –	750	– –	235	– –	– –	900,000
	1500 f Industrial*	A	1500	1650	130	145	1250	1350	460	505	1000	1100	1,730,000
		B	1200	1350	105	115	1050	1150	235	255	800	900	1,450,000
	1200 f Industrial*	A	1300	1400	120	130	1050	1150	460	505	850	950	1,560,000
		B	1050	1150	95	105	900	1000	235	255	700	750	1,310,000

ESGC	Select Merchantable	C	– –	1350	– –	125	– –	1250	– –	335	– –	– –	1,260,000
		D	– –	1050	– –	100	– –	1050	– –	245	– –	– –	1,210,000
		F	– –	1050	– –	90	– –	800	– –	180	– –	– –	1,160,000
	Construction	C	– –	850	– –	105	– –	1050	– –	335	– –	– –	1,000,000
		D	– –	650	– –	85	– –	900	– –	245	– –	– –	970,000
		F	– –	650	– –	75	– –	650	– –	180	– –	– –	930,000
	Standard	C	– –	650	– –	80	– –	950	– –	335	– –	– –	1,000,000
		D	– –	500	– –	65	– –	800	– –	245	– –	– –	970,000
		F	– –	500	– –	55	– –	600	– –	180	– –	– –	930,000
CLA EPGC NELMA	No. 1	E	– –	950	– –	110	– –	900	– –	240	– –	– –	1,150,000
	No. 2	E	– –	850	– –	100	– –	850	– –	240	– –	– –	1,030,000
	No. 3	E	– –	450	– –	60	– –	650	– –	240	– –	– –	920,000
	No. 1 Dimension	E	– –	600	– –	60	– –	800	– –	240	– –	– –	920,000
	No. 2 Dimension	E	– –	350	– –	60	– –	600	– –	240	– –	– –	920,000
CLA ESGC	Select Structural #	C	1550	1750	120	130	1150	1250	335	370	1050	1150	1,260,000
		D	1250	1350	85	95	950	1050	245	265	850	900	1,210,000
		E	1150	1300	95	100	850	950	235	260	800	850	1,130,000
		F	1250	1350	85	95	750	800	180	195	850	900	1,160,000
	Structural #	C	1350	1450	120	130	950	1050	335	370	900	1000	1,260,000
		D	1050	1150	85	95	800	900	245	265	700	800	1,210,000
		E	1000	1100	95	100	700	750	235	260	650	750	1,130,000
		F	1050	1150	85	95	600	650	180	195	700	800	1,160,000

Notes to Table V(a):

1. Stresses apply only to light framing lumber 2 in. to 4 in. in nominal thickness and 4 in. in nominal width. For grades marked (*) stresses also apply to members 3 in. in nominal width.
2. Yellow Birth, Hard Maple and Red and White Oak of CSA "Select Structural" or "Structural" grades have the same allowable unit stresses as Group A for "Select Structural" or "1500 f Industrial" grades respectively.
3. An approximate value for modulus of rigidity may be estimated as 0.065 times the modulus of elasticity.

Allowable unit stresses in tension parallel to grain apply only when grade restrictions applicable to the middle third of the piece are applied over the full length of the piece.

TABLE V(b)

ALLOWABLE UNIT STRESSES FOR JOIST AND PLANK SIZES OF SAWN LUMBER, PSI

(Thickness: 2 to 4 in.; Width: 6 in. or more; Dry Service Conditions; Normal Duration of Load)

GRADING RULE	GRADE	Species Group	BENDING				COMPRESSION				Tension Parallel to Grain		Modulus of Elasticity
			Stress at Extreme Fibre		Longitudinal Shear		Parallel to Grain		Perpendicular to Grain				
			Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	
BCLMA WCLIB WWPA	Select Structural*	A	1750	1900	130	145	1400	1550	460	505	1150	1250	1,730,000
		B	1300	1400	105	115	1150	1250	235	255	850	950	1,450,000
	Select Merchantable	C	– –	1450	– –	105	– –	1300	– –	335	– –	1000	1,260,000
		D	– –	1150	– –	75	– –	1100	– –	245	– –	750	1,210,000
		E	– –	1100	– –	85	– –	1200	– –	235	– –	750	1,130,000
	Construction*	A	1500	1650	110	125	1200	1300	460	505	1000	1100	1,730,000
		B	1200	1350	90	100	1100	1250	235	255	800	900	1,450,000
	Construction	C	– –	1050	– –	105	– –	1100	– –	335	– –	700	1,130,000
		D	– –	800	– –	75	– –	950	– –	245	– –	550	1,090,000
		E	– –	850	– –	85	– –	1050	– –	235	– –	550	1,010,000
	Standard*	A	1250	1350	85	90	1100	1200	460	505	800	900	1,560,000
		B	1050	1150	65	75	1000	1050	235	255	700	750	1,310,000
	Standard	C	– –	600	– –	80	– –	900	– –	335	– –	400	1,000,000
		D	– –	450	– –	55	– –	750	– –	245	– –	300	970,000
		E	– –	500	– –	65	– –	850	– –	235	– –	300	900,000
	Utility	A	– –	550	– –	85	– –	850	– –	460	– –	350	1,380,000
		B	– –	400	– –	65	– –	700	– –	235	– –	250	1,160,000
		C	– –	400	– –	80	– –	750	– –	335	– –	250	1,000,000
		D	– –	300	– –	55	– –	600	– –	245	– –	200	970,000
		E	– –	300	– –	65	– –	700	– –	235	– –	200	900,000

ESGC	Selected Merchantable	C	– –	1500	– –	125	– –	1300	– –	335	– –	1000	1,260,000
		D	– –	1200	– –	100	– –	1100	– –	245	– –	800	1,210,000
		F	– –	1200	– –	90	– –	850	– –	180	– –	800	1,160,000
	Construction	C	– –	1300	– –	105	– –	1200	– –	335	– –	900	1,260,000
		D	– –	1050	– –	85	– –	1050	– –	245	– –	700	1,210,000
		F	– –	1050	– –	75	– –	800	– –	180	– –	700	1,160,000
	Standard	C	– –	1100	– –	80	– –	1100	– –	335	– –	700	1,130,000
		D	– –	850	– –	65	– –	950	– –	245	– –	550	1,090,000
		F	– –	850	– –	55	– –	700	– –	180	– –	550	1,040,000
CLA EPGC NELMA	No. 1	E	– –	950	– –	110	– –	900	– –	240	– –	650	1,150,000
	No. 2	E	– –	850	– –	100	– –	850	– –	240	– –	550	1,030,000
	No. 3	E	– –	400	– –	60	– –	650	– –	240	– –	300	920,000
	No. 1 Dimension	E	– –	750	– –	60	– –	800	– –	240	– –	500	1,030,000
	No. 2 Dimension	E	– –	450	– –	60	– –	650	– –	240	– –	300	920,000
CLA ESGC	Select Structural*	C	1550	1700	120	130	1100	1200	335	370	1050	1150	1,260,000
		D	1200	1350	85	95	950	1000	245	265	800	900	1,210,000
		E	1150	1250	95	100	800	900	235	260	750	850	1,130,000
		F	1200	1350	85	95	700	750	180	195	800	900	1,160,000
	Structural*	C	1300	1450	120	130	950	1000	335	370	900	950	1,260,000
		D	1050	1150	85	95	800	850	245	265	700	750	1,210,000
		E	950	1050	95	100	700	750	235	260	650	700	1,130,000
		F	1050	1150	85	95	600	650	180	195	700	750	1,160,000

Notes to Table V(b):

1. Stresses apply only to joist and plank sizes of dimension lumber 2 in. to 4 in. in nominal thickness and 6 in. or more in nominal width.
2. Yellow Birch, Hard Maple and Red and White Oak of CSA "Select Structural" or "Structural" grades have the same allowable unit stresses as Group A for "Select Structural" or "Construction" grades respectively.
3. An approximate value for modulus of rigidity may be estimated as 0.065 times the modulus of elasticity.
4. Tension parallel to grain stresses for the following grades apply only when pieces are selected to ensure they do not exceed maximum slope of grain limitations:
   - Select(ed) Merchantable grade to BCLMA, WCLIB, WWPA and ESGC grading rules – maximum slope 1 in 11.
   - Construction grade to ESGC grading rule, and No. 1 and No. 2 grades to CLA, EPGC and NELMA grading rules maximum slope 1 in 9.
   - Construction grade to BCLMA, WCLIB and WWPA grading rules, Standard grade to ESGC grading rules, and No. 1 Dimension grade to CLA, EPGC and NELMA grading rules – maximum slope 1 in 7.

* Allowable unit stresses in tension parallel to grain apply only when grade restrictions applicable to the middle third of the piece are applied over the full length of the piece.

TABLE V(c)

ALLOWABLE UNIT STRESSES FOR STRUCTURALLY GRADED SAWN LUMBER, PSI

(Minimum Thickness: 5 in.; Dry Service Conditions; Normal Duration of Load)

GRADING RULE	GRADE	Species Group	BENDING				COMPRESSION				Tension Parallel to Grain		Modulus of Elasticity
			Stress at Extreme Fibre		Longitudinal Shear		Parallel to Grain		Perpendicular to Grain				
			Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	
(a) Beams and Stringers – depth more than 2 inches greater than thickness													
BCLMA WCLIB WWPA	Select Structural*	A	1700	1850	130	140	1100	1250	460	505	1150	1250	1,730,000
	Construction*	A	1350	1500	130	140	950	1050	460	505	900	1000	1,730,000
		B	1200	1300	105	115	850	950	235	255	800	850	1,450,000
CLA ESGC	Select Structural*	C	1500	1650	120	130	950	1050	335	370	1000	1100	1,260,000
		D	1200	1300	85	95	800	900	245	265	800	900	1,210,000
		E	1100	1200	90	100	700	750	235	260	750	800	1,130,000
		F	1200	1300	85	95	600	650	180	195	800	850	1,160,000
	Structural*	C	1200	1300	120	130	750	850	335	370	800	900	1,260,000
		D	950	1050	85	95	650	700	245	265	650	700	1,210,000
		E	900	1000	90	100	550	600	235	260	600	650	1,130,000
		F	950	1050	85	95	500	550	180	195	650	700	1,160,000

(b) Posts and Timbers – depth more than 2 inches greater than thickness													
BCLMA WCLIB WWPA	Select Structural	A	1550	1700	85	95	1200	1300	460	505	1050	1150	1,730,000
	Construction	A	1250	1400	85	95	1000	1100	460	505	850	950	1,730,000
		B	1100	1200	70	75	900	1000	235	255	750	800	1,450,000
CLA ESGC	Select Structural	C	1250	1400	95	105	950	1000	335	370	850	950	1,260,000
		D	1000	1100	70	75	800	850	245	265	650	750	1,210,000
		E	950	1050	75	80	700	750	235	260	600	700	1,130,000
		F	1000	1100	70	75	600	650	180	195	650	750	1,160,000
	Structural	C	900	950	80	85	750	850	335	370	600	650	1,260,000†
		D	700	750	55	60	650	700	245	265	450	500	1,210,000†
		E	650	700	60	65	550	600	235	260	450	500	1,130,000†
		F	700	750	55	60	500	550	180	195	450	500	1,160,000†

Notes to Table V(c):

1. Stresses apply only to sawn timbers 5 in. or more in least nominal dimension.
2. Bending stresses for "beams and stringers" apply only when a member is loaded on the narrow face.
3. "Posts and timbers" graded to "beam and stringer" rules may be assigned beam and stringer stresses.
4. Yellow Birch, Hard Maple and Red and White Oak of CSA "Select Structural" or "Structural" grades have the same allowable unit stresses as Group A for "Select Structural" or "Construction" grades respectively.
5. An approximate value for modulus of rigidity may be estimated as 0.065 times the modulus of elasticity.
6. With sawn members thicker than 4 in., which season slowly, care should be exercised to avoid overloading in compression before appreciable seasoning of the outer fibres has taken place, otherwise compression stresses for wet service conditions shall be used.

* Allowable unit stresses in tension parallel to grain apply only when grade restrictions applicable to the middle third of the piece are applied over the full length of the piece.

† Modulus of elasticity applies to this grade only when used as a post; if designed as a beam, reduce modulus of elasticity by 20%.

TABLE V(d)

ALLOWABLE UNIT STRESSES FOR PLANK DECKING, PSI

Thickness 2 to 4 Inches; Width 6 Inches or More

Dry Service Conditions Normal Duration of Load

GRADING RULE	GRADE	Species Group	Bending Stress at Extreme Fibre		Compression Perpendicular to Grain		Modulus of Elasticity
			Single Member Uses	Load Sharing Uses	Single Member Uses	Load Sharing Uses	
BCLMA WCLIB WWPA	Select	A	1450	1600	460	505	1,730,000
		B	1100	1200	235	255	1,450,000
		C	1300	1400	335	370	1,260,000
		D	1000	1100	245	265	1,210,000
		E	1000	1100	235	260	1,130,000
	Commercial	A	1200	1300	460	505	1,560,000
		B	900	1000	235	255	1,310,000
		C	1050	1150	335	370	1,130,000
		D	850	900	245	265	1,090,000
		E	800	900	235	260	1,010,000
ESGC	Selected Merchantable	C	– –	1850	– –	335	1,260,000
		D	– –	1500	– –	245	1,210,000
		F	– –	1500	– –	180	1,160,000
	Construction	C	– –	1700	– –	335	1,260,000
		D	– –	1350	– –	245	1,210,000
		F	– –	1350	– –	180	1,160,000
	Standard	C	– –	1550	– –	335	1,260,000
		D	– –	1250	– –	245	1,210,000
		F	– –	1250	– –	180	1,160,000
CLA EPGC NELMA	No. 1	E	– –	1250	– –	240	1,150,000
	No. 2	E	– –	1200	– –	240	1,150,000
	No. 3	E	– –	850	– –	240	1,030,000
	No. 1 Dimension	E	– –	1100	– –	240	1,150,000
	No. 2 Dimension	E	– –	850	– –	240	1,030,000

Notes to Table V(d):

1. Stresses apply only to plank decking 2 in. to 4 in. in nominal thickness and 6 in. or more in nominal width, loaded on their wide face.
2. An approximate value for modulus of rigidity may be estimated as 0.07 times the modulus of elasticity.
3. Lumber grades should be specified by intended end use (e.g. light framing, joist and plank, beam and stringer, post and timber), as well as species and grade. Designers are advised to check the availability of grade, species, and size of members required before specifying.

1.1.4.3. Structural Assemblies

(1) Structural assemblies may be designed in accordance with the relevant clauses of the Chapter on Wood in NBC Supplement No. 4, Canadian Structural Design Manual, 1970, or may be evaluated on the basis of load tests.

(2) Where the design of structural assemblies for low human occupancies 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 hr without failure.

1.1.4.4. Glued Structural Assemblies

(1) Glued structural assemblies including glulam, should be exterior grade.

SUBSECTION 1.1.5. UNIT MASONRY

1.1.5.1. General

Except as provided for in this Section, the design of unit masonry should conform to the requirements of the Chapter on Plain, Reinforced or Grouted Masonry in NBC Supplement No. 4, Canadian Structural Design Manual, 1970.

1.1.5.2. 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) 6 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) 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.

1.1.5.3. 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, or,

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

1.1.5.4. Lintels

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

1.1.5.5. Roof anchorage

Roofs should be securely anchored to masonry walls to prevent lifting from high winds. Anchorage should be by means of anchor bolts of suitable size, properly spaced and adequately embedded in concrete, or by other effective methods.

1.1.5.5.

Reference should be made to the Canadian Structural Design Manual, 1970, (NBC Supplement No. 4) for information on Pressure and Force Coefficients for Wind Loads.

1.1.5.6 Mortar

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

1.1.5.7. 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.

SUBSECTION 1.1.6. CONCRETE

1.1.6.1. General

Except as otherwise provided in this Section the design of farm buildings or structural elements made from concrete or concrete products should be in accordance with the Chapter on Concrete in NBC Supplement No. 4, Canadian Structural Design Manual, 1970.

1.1.6.2. 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.

1.1.6.3. Ready-mixed Concrete

Ready-mixed concrete should conform to the requirements of CSA Specification A23-1, 1967, "Concrete Materials and Methods of Concrete Construction," published by the Canadian Standards Association. (See Appendix B, Table B-II, for guide for ordering ready-mixed concrete.)

1.1.6.4. On-site Mixing

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

1.1.6.5. Concrete Floors

(1) The minimum thickness of floors other than slabs-on-grade, should be 3½ in.

(2) Subgrade

(a) The subgrade should be free of sod, large stones, 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

Isolation joints should be used to prevent floating floors from bonding to foundation walls, columns or other rigid parts of buildings.

(4) Watertight floors

(a) A vapour barrier of 0.006 polyethylene or equivalent should be laid over the subgrade. Where strip material is used a 4-in. lap should be maintained.

(b) In wet areas, a minimum of 4 in. of granular material should be placed over the subgrade followed by a vapour barrier as outlined in (a). Adequate drainage by means of drain pipe should also be provided.

1.1.6.6. Concrete Pavements

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

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

(3) Joints should be provided to control cracking.

1.1.6.7. Concrete Silo

(1) Foundations

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

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

(2) Footings

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

(b) For a vertical cylindrical wall centred on an annular footing of any type, the width at the base of the footing required to support the wall and vertical friction loads is given by formula

$$w = \frac{12h_1}{p} (12.5t + 2.64h_1^{1.08})$$

where w = width of footing, in. at the base
h_1 = distance from top of silo to top of footing,
t = thickness of wall, in.
p = allowable soil pressure, psf.

(c) For a cylindrical wall centred on a plain annular footing, the depth of the footing should be calculated by formula

$$d = \sqrt{pw}/131$$

where p = allowable soil pressure, psf
w = width of footing, in., as calculated from formula in (b)
d = depth of footing, in.

(3) Hoops

The maximum hoop spacing should be 30 in.

(4) Construction tolerances

(a) The roundness of a concrete silo expressed as the difference between the largest inside diameter and the smallest inside diameter should not exceed 0.4 in. per foot in diameter.

(b) The plumbness of a concrete silo expressed as the maximum distance from the plumb line that the silo departs should not exceed 1 in. in 10 ft of height.

(5) Stave silos

(a) Stave silo walls should be of such quality or be treated to resist the action of silage acid.

(6) Cast-in-place silos

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

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

(c) Design procedures for cast-in-place silos with heights equal to at least twice the diameters are presented in a report "Suggested Specification

for Construction of Precast Concrete Stave Farm Silos," by Committee 313, "Concrete Bins and Silos" of the American Concrete Institute.

SUBSECTION 1.1.7 STEEL

Except as provided for in Article 1.1.2.2. the design of farm buildings or structural elements made from steel products should be in accordance with the Chapter on Steel Construction of the Canadian Structural Design Manual, 1970 (NBC Supplement No. 4) and with Section 4.8, Cladding, of the National Building Code of Canada, 1970.

SUBSECTION 1.1.8. ALUMINUM

Except as provided for in Article 1.1.2.2. the design of farm buildings or structural elements made from aluminum products should be in accordance with the Chapter on Aluminum of the Canadian Structural Design Manual, 1970 (NBC Supplement No. 4) and with Section 4.8, Cladding, of the National Building Code of Canada, 1970.

SUBSECTION 1.1.9. CLADDING

The design, properties and application of cladding for farm buildings should be in accordance with Section 4.8, Cladding, of the National Building Code of Canada, 1970, except as provided for in Subsection 2.3.2. of this Code.

SECTION 1.2. HAZARD AND SAFETY

This Section deals with the hazards and methods of minimizing losses from fire, and the prevention of accidents.

SUBSECTION 1.2.1. FIRE

1.2.1.1. Classification of Building Occupancies by Fire Hazards

(1) Division I buildings – high fire 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 in quantities exceeding 5 gal., and ammonium nitrate fertilizer storage in quantities exceeding 100 lb.

(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 within the structures operating at a surface temperature of 325°F or greater creates an additional fire hazard).

(d) Farm machine maintenance shops.

(2) Division II buildings – moderate fire hazard

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

Small grain drying and storage,
Animal and plant production (except as in Clause 1.2.1.1.(1)(c)),
Silage storage,
Fruit and vegetable preparation and storage,
Baled tobacco storage,
Milk storage and handling
Equipment and vehicle storage.

1.2.1.2. Measures Designed to Prevent the Spread of Fire within a Fire compartment.

"Fire compartment," in this Section, means a building or part of a building that is required by this Code to be separated from another building or part of a building by fire separation. A fire 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 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.

1.2.1.3. Measures Designed to Retard the Spread of Fire Between Abutting Compartments or Between Buildings Separated by less than 20 ft of Open Space

"Fire-resistance 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 E119-67, Fire Tests of Building Construction and Materials, published by the American Society for Testing and Materials, or British Standard BS476, Fire Tests on Building Materials and Structures, published by the British Standards Institution, or other acceptable test standards. Fire-resistance ratings of elements or assemblies that have not been tested can be established on the basis of Supplement No. 2 to the National Building Code, Fire Performance Ratings, 1970. Additional fire-resistance ratings of tested elements and assemblies are contained in Part 9 of the National Building Code of Canada, 1970.

"Fire separation," in this Section, means a barrier against the spread of fire in the form of construction which may or may not have a fire resistance rating and in which openings are protected by closures having a fire resistance rating at least equal to the remaining area of the barrier. (See Tables C-I to C-III in Appendix C for fire resistance ratings of some typical farm construction.)

(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 5000 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 and Ammonium Nitrate Fertilizer 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 a 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 from 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.

(5) Fire resistive closures

(a) Openings and shafts penetrating fire separations should be fitted with fire resistive closures tested by a recognized laboratory in accordance with ASTM Standard E152-66, Fire Tests of Door Assemblies, published by the American Society for Testing and Materials, or similar test standards.

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

(c) A duct that passes through a fire separation should be equipped with an automatic damper that operates at a temperature 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.

1.2.1.4. Fire Separation by Open Space Between Buildings

(1) Construction types

(a) Type I construction has a fire-resistance rating of less than 30 minutes for either the walls, or the ceiling and roof, of the fire compartment.

(b) Type II construction has a fire-resistance rating of at least 30 minutes and has unprotected openings not exceeding 5 per cent of the exposing compartment wall area. Alternatively, type II construction may have a fire-resistance rating of at least 45 minutes and unprotected openings not exceeding 12 per cent of the exposing compartment wall area.

(c) Type III construction has a fire-resistance rating of at least 45 minutes and has unprotected openings not exceeding 5 per cent of the exposing compartment wall area.

Note: Where conditions of construction type are not met, use values for lower type construction.

(2) To prevent the spread of fire by radiation, space separations should be as indicated in Tables VI(a), (b), (c), and (d).

Note: Table VI does not provide protection against wind carried embers where the adjacent buildings have exposed wall or roof openings or low sloped roofs which can be ignited by prolonged contact with the embers.

TABLE VI(a)

MINIMUM SPACE SEPARATIONS FOR PREVENTION OF RADIATION FIRE SPREAD TO ADJACENT BUILDINGS HAVING ASPHALT BASE SIDING OR MANUFACTURED HARDBOARD SIDING

Dimensions of Fire Compartment Seen by Adjacent Building, Length x Ridge Height, ft	Construction Type of Burning Building		
	I	II	III
	Space Separation, ft		
20 by 12	40	35	25
50 by 12	65	50	35
100 by 12	80	60	40
80 by 30	115	95	65

TABLE VI(b)

MINIMUM SPACE SEPARATIONS FOR PREVENTION OF RADIATION FIRE SPREAD TO ADJACENT BUILDINGS HAVING WOOD OR PLYWOOD SIDING

Dimensions of Fire Compartment Seen by Adjacent Building, Length x Ridge Height, ft	Construction Type of Burning Building		
	I	II	III
	Space Separation, ft		
20 by 12	35	30	20
50 by 12	55	45	30
100 by 12	65	55	35
80 by 30	105	90	60

1.2.1.4.

TABLE VI(c)

MINIMUM SPACE SEPARATIONS FOR PREVENTION OF RADIATION FIRE SPREAD TO ADJACENT BUILDINGS HAVING SIDING OF NONCOMBUSTIBLE, NONREFLECTIVE MATERIAL*, AND HAVING NO WINDOWS OR OTHER OPENINGS IN THE EXPOSED SIDES

Dimensions of Fire Compartment Seen by Adjacent Building, Length x Ridge Height, ft	Construction Type of Burning Building		
	I	II	III
	Space Separation, ft		
20 by 12	30	30	20
50 by 12	50	40	25
100 by 12	55	45	30
80 by 30	85	70	50

Note to Table VI(c):

* Materials such as asbestos-cement, painted metal, soiled metal or stucco which will absorb most of the radiation received.

TABLE VI(d)

MINIMUM SPACE SEPARATIONS FOR PREVENTION OF RADIATION FIRE SPREAD TO ADJACENT BUILDINGS HAVING SIDING OF NONCOMBUSTIBLE REFLECTIVE MATERIAL*, AND HAVING NO WINDOWS OR OTHER OPENINGS IN THE EXPOSED SIDES

Dimensions of Fire Compartment Seen by Adjacent Building, Length x Ridge Height, ft	Construction Type of Burning Building		
	I	II	III
	Space Separation, ft		
20 by 12	25	20	20
50 by 12	30	25	20
100 by 12	35	30	20
80 by 30	55	40	25

Note to Table VI(d):

* Materials such as unpainted galvanized steel or aluminum which will reflect most of the radiation received.

Note:

The National Building Code, 1970, Part 3, Use and Occupancy, gives fire separation distances for other situations which may occasionally be applicable to farm buildings. Distances given in the Code should only be used if the buildings comply with the other fire requirements of the Code such as fire separation, noncombustible construction and window area.

1.2.1.5. 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

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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 2.1.1.1.(6)(h) and (i).

"Exit (for farrowing sows)" in this Section means an opening at least 22 in. by 36 in. located at floor level and leading to open space. Where the total change in floor elevation exceeds 10 in., a cleated or grooved ramp should be provided.

(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 1 (see Clause 1.2.1.1.(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 2000 sq ft, except when used for bulk crop storage where one exit is adequate.

SUBSECTION 1.2.2. HEATING AND REFRIGERATION

1.2.2.1. General

(1) All heating equipment should be CSA approved and be in accordance with CSA Specifications B140 series for all oil and gas-fired equipment. Brooders and incubators should be CSA approved and be in accordance with CSA Electrical Code CSA C22.2, No. 102-1958 reaffirmed 1965. All electrical refrigeration equipment should be CSA approved and be in accordance with C22.2, No. 32-1954. All equipment should be installed in accordance with Provincial regulations.

(2) Where fuels are burned in greenhouses, a separate combustion air and flue system should be provided. Where carbon dioxide control is required for growth regulation, the use of specifically designed CO_2 generators is recommended.

(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) Gas-fired infrared type poultry hovers should be provided with suitable dust filters to prevent combustible material contacting radiating surfaces.

(5) Supplementary combustion-fired heating units for product storage buildings or livestock structures should be housed in a separate structure or room in accordance with requirements for Division I buildings as defined in Article 1.2.1.1.

(6) If any type of combustion heating unit with forced air is 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 on heating units of comparable size.

SUBSECTION 1.2.3. ELECTRICAL SERVICES

1.2.3.1. Service Entrance and Metering

(1) All buildings should be served from a stepdown transformer located centrally in relation to the electrical loading.

(2) The power supplier should be consulted for requirements and regulations governing service entrance and metering equipment. Most power authorities will provide drawings and other assistance. NOTE: An application for inspection by the authority having jurisdiction is required for all electrical installations before work is commenced. Consult the power supply authority. For further reference, consult the Canadian Electrical Code.

1.2.3.2. The Size of Service Wire for a Building Supplied at 120/240 Volts

(1) The minimum size of wire should be determined by totaling the ampere values calculated in each of the following steps (a) to (e).

(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). See Tables L-IV and L-V in Appendix L for full load current of common sizes of motors.

(b) The full load amperage of all other permanently connected equipment.

(c) One-half the full load amperage of all portable equipment that is operated at 120 volts.

(d) All convenience outlets at ¾ ampere per outlet

(e) All lighting outlets at ¾ ampere per outlet, or if restricted lighting is used (e.g. 25, 40 or 60 watts per outlet in a poultry house) calculate one-half of the total connected lighting load in amperes.

(2) The minimum size of wire required for a 120/240 volt 3-wire service, should be on a maximum voltage drop of 2 per cent and length and type of wire (Tables L-I to L-III, Appendix L).

(3) The neutral conductor must be sized to carry the maximum unbalanced load, i.e. one-half of the connected 115-volt load (Table L-III, Appendix L) but shall not in any case be smaller in size than the grounding conductor required to ground the service or feeder (Table L-VI, Appendix L).

(4) Determining service switch capacity

(a) The capacity of the service switch in each building shall be the next higher rating to that required by the wire size calculated in Sentence 1.2.3.2.(1) or (2) whichever is the larger.

(b) Where the continuous load is in excess of 80 per cent of the connected load the switch shall have the next higher capacity to that determined in Sentence 1.2.3.2.(1).

1.2.3.3. Emergency Service

(1) A double throw switch must be used in conjunction with a standby generator to prevent backfeed onto the line.

(2) The generator should be properly grounded.

1.2.3.4. Lighting Outlets for Particular Locations

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

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

(3) Lighting fixtures in feed grinding rooms, feed storages, hay mows and other dusty locations should be of dustproof type.

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(4) Provide at least two lighting outlets controlled by three-way switches for each stairway, unless the head and foot of stairway are adequately lighted from other sources.

1.2.3.5. Locations of Convenience Outlets

Convenience outlets, where required, should be located as high as can be reached conveniently to avoid damage from stock. Where practical these outlets should be mounted flush with wall.

1.2.3.6. Location of Wall Switches

Wall switches should be mounted at a height of approximately 52 in. above the floor line. Switches should not be located in areas where livestock are penned.

1.2.3.7. Multiple-switch Control

All spaces for which wall switch control is required, and which have more than one entrance, should be equipped with a multiple-switch control at each principal entrance.

1.2.3.8. Outlets

Convenience outlets should be provided for portable equipment to eliminate extensive use of extension cords. These outlets should be the 3-pronged grounded type.

1.2.3.9. Motors on Fixed Equipment

(1) All ventilating, refrigerating and other such equipment and controls should be CSA approved and be installed in accordance with CSA Specification C22.1-1969, Canadian Electrical Code, Part I, Section 28, Motors.

(2) Motors over 1/3 horsepower should be operated on a separate circuit.

(3) Motors over 1/2 horsepower should be on 230-volt circuits.

(4) Motors 1/3 horsepower and under may be connected to convenience outlet circuits if provided with individual motor overload protection.

1.2.3.10. Protection

(1) Each branch circuit should be protected by fuses or circuit breakers whose ratings do not exceed the rating of circuit conductors.

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

1.2.3.11. Grounding

(1) A grounding electrode should be installed at every major building on the farm where service is provided. The electrode should consist of one or more ground rods, driven into the ground and suitably interconnected. Ground rods should be at least 10 ft in length.

(2) To reduce the hazard to humans and livestock from lightning and electrical failure in equipment or wiring, all metal components, including those not directly connected with the electrical system (stanchions, metal pens, etc.) should be bonded together by a substantial copper conductor (not less than No. 8 American Wire Gauge) and connected to the electrical system ground.

(3) Provision should be made for the grounding of the non-current-carrying metal parts of all electrical equipment through proper receptacles with particular attention given to portable tools and equipment.

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(4) All non-current-carrying metal parts of water systems, including remote pumping systems should be bonded to the system neutral by a separate conductor. When plastic pipe is used, a separate ground should be installed.

1.2.3.12. Floor Heating Cable

(1) Floor heating cable for use in livestock and poultry applications should be CSA approved for that purpose.

SUBSECTION 1.2.4. LIGHTNING

1.2.4.1. Lightning Rods

(1) Provincial Lightning Rod Acts and CSA Specification B72-1960, Code for the Installation of Lightning Rods, 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 not more than 165 ft.

SUBSECTION 1.2.5. SAFETY

1.2.5.1. Overhead Obstructions

(1) Litter alleys and feed alleys should have no obstructions below 6 ft 6 in. from the floor.

1.2.5.2. 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 except for loading docks.

(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) Adequate guard rails should be provided for livestock.

1.2.5.3. Stairways

(1) Where an exit door opens outwards towards a stair, the full arc of its swing should be over a landing.

(2) Where steps occur in walkways there should be 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.

1.2.5.4. 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) Permanently installed ladders should terminate 5 ft above ground for child safety.

1.2.5.4.

(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 7 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.

(7) The distance between side rails should be 10 in. minimum.

(8) Safety cages should be provided around permanently installed ladders more than 20 ft in height.

1.2.5.5. Bull Pens

Bull pens should be provided with safety areas and a protected means of human egress.

1.2.5.6. Water Systems

(1) All water heating equipment should

(a) carry the approval of the Canadian Underwriters Laboratories or the Canadian Standards Association,

(b) be installed in accordance with the manufacturer's recommendation, and

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

(2) Temperature-sensitive plastic pipe should not be used for hot water applications.

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

(4) Manhole covers or portions thereof should weigh at least 40 lb, or be equipped with a locking device for child safety.

1.2.5.7. Liquid Manure Storage Tanks

(1) Covered liquid manure storage tanks should have openings for equipment access. Access covers should weigh not less than 40 lb, should not float and should be lipped, or alternatively the opening should be rabbeted. Where the access is rectangular, the length and width of the cover should exceed the corresponding dimensions of the opening.

(2) Covers over liquid manure storage tanks should be designed to support any expected loads imposed by livestock or equipment.

(3) Open-top manure storage tanks or pits should be protected by a fence so designed as to exclude children and domestic animals.

(4) Where liquid manure tanks are open within livestock buildings, maximum ventilation should be provided during agitation. Provide zero or positive room ventilation pressure while outside hatches are open into the manure storage. Humans and, if possible, livestock should be evacuated.

(5) Where liquid manure tanks are located outside of livestock buildings and have openings to the buildings, gas traps or valves should be installed to prevent dangerous gases from entering buildings during agitation.

1.2.5.7.

(6) To discourage entry, fixed ladders should not be permanently installed in liquid manure tanks.

1.2.5.8. Chemical Storage

(1) Provision should be made for convenient and safe locked storage of dangerous chemicals on the farmstead.

(2) Storage for ammonium nitrate fertilizer should be isolated from liquid fuel storage.

1.2.5.9. 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.

SECTION 1.3 HEALTH AND SANITATION

This Section relates to services and building requirements which will permit the maintenance of structures in a condition conducive to the good health of animals and suitable for sanitary, nuisance-free production of agricultural products. Local authorities should be consulted concerning air and water pollution control regulations.

SUBSECTION 1.3.1. WATER SOURCES

1.3.1.1. General

(1) Sources 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, and where testing indicates water from any source requires treatment, 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.

1.3.1.2. Wells

(1) Wells should be at locations that are safe from pollution.

(2) Drilled wells should be provided with a casing of watertight material effectively sealed against pollution for a minimum distance of 1 ft above grade and 10 ft below grade and be equipped with a sanitary well cap.

(3) Dug wells should be:

(a) provided with a tight-fitting impervious cover (see Sentences 1.2.5.6.(3) and (4),

(b) provided with a watertight casing extending at least 10 ft below grade and 1 ft above grade, and

(c) located and so graded as to divert surface water.

(4) After construction or repair, wells should be (a) pumped until the water runs clear and (b) disinfected.

1.3.1.3. Springs

(1) Springs may be used as a source of water but special precautions should be taken to avoid contamination.

1.3.1.3.

(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 box contructed of durable non-toxic material such as concrete, galvanized metal or other suitable material, that is well flushed and disinfected before water is delivered to the supply lines. The box should have a tight fitting impermeable cover (see Sentences 1.2.5.6.(3) and (4)).

1.3.1.4. 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 as a potable supply, special treatment is essential. Local health authorities should be consulted.

(3) Open surface water sources should be fenced to reduce contamination by livestock.

SUBSECTION 1.3.2. WASTES

1.3.2.1. General

(1) All wastes on farms should be disposed of in a safe and sanitary manner. Liquid wastes should not be allowed to drain away, either by surface or subsurface drains, into any runway, watercourse, open ditch, stream, river or to a groundwater body, but should be disposed of in such a manner that no possible pollution can occur. Local health and/or water authorities should be consulted before manure storage or disposal facilities are established.

(2) (i) A lavatory should be provided in areas used for the collection, handling, processing and storage of food products where a worker continuously occupies the building for 4 hr or more on a regular basis.

(ii) Where a group of buildings are in close proximity, and where there is no requirement for isolation (animal diseases, etc.) one convenient lavatory facility may serve the group of buildings.

(iii) Disposal of human waste should be separate from animal and milk room wastes, and should conform with requirements of Provincial health departments or other local authority.

(3) Plumbing for drainage of wastes in areas used for the collection, handling, processing and storage of food products should meet the requirements of Part 7, Plumbing Services, of the National Building Code of Canada, 1970.

(4) Livestock enterprises should be established where acceptable means of waste disposal are available. For waste disposal by spreading on farm land, see Article 2.2.6.5.

1.3.2.2. Manure Storage

(1) Manure should be stored in a watertight structure. Storage structures in high water-table areas should be constructed above the water table, or otherwise designed to resist external hydrostatic pressures.

(2) Where manure will be stored in solid form:

(a) The storage capacity should be based on the type and number of animals and the frequency of manure removal. (See Article 2.2.6.1.)

(b) The storage structure should be accessible by solid manure handling equipment.

1.3.2.2.

(3) Where manure will be stored in liquid form:

(a) The storage capacity should be based on the type and number of animals, the frequency of manure removal, and the volume of required dilution water. (See Article 2.2.6.1.)

(b) The storage structure should be:

(i) designed to allow complete removal of the liquid manure,

(ii) provided with adequate ventilation for safety (see Sentence 1.2.5.7.(4)).

(iii) Accessible by liquid manure handling equipment.

1.3.2.3. **Dead Animal Disposal Pits**

(1) Disposal pits should be located at least 150 ft from any well or spring used as a water supply.

(2) Disposal pits should be made of metal, concrete, or other material approved by local authorities, be constructed to exclude insects and rodents, and be waterproof.

(3) Pits should be covered with tight-fitting lids and a locking device.

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

1.3.2.4. **Dairy Wastes**

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

(a) All washings of manure from milking parlour floors and other floors should be delivered to a liquid manure tank.

(b) All wash waters from milkrooms, 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 containing milk wastes should be piped to a sediment tank. (see Sentence 2.2.6.3.(1).)

(c) Overflow from the sediment tank should be carried to an underground disposal field, or other forms of final disposal approved by local health authorities. (see Sentence 2.2.6.3.(2).)

(d) Provision should be made for periodic cleaning of the sediment tank.

1.3.2.5. **Manure Lagoons**

"Manure lagoon" means a structure specifically designed to treat livestock wastes by biological, chemical and physical processes.

(1) The local health and/or water authorities should be consulted before lagoon size and location is determined. (see Article 2.2.6.4.)

(2) A lagoon should be located:

(a) in an area with adequate room for expansion,

(b) on the leeward side of the house,

(c) an adequate distance from any living area to avoid being a nuisance,

(d) to exclude, or in low rainfall areas to control, surface drainage to lagoons from adjacent areas,

(e) where it is not possible to contaminate surface and well water supplies,

(f) in a location exposed to the wind,

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(g) where the subsoil is impervious; if pervious subsoil is encountered, a lagoon should be provided with an impervious lining.

(3)

(a) A lagoon should be enclosed by a fence to exclude children and livestock.

(b) Signs should be attached to the fencing to indicate the purposes of the lagoon and give warning of any danger involved.

1.3.2.6. Incinerators

(1) Incinerators when used for the disposal of dead animals should be designed to consume all material and should meet Incinerator Institute of America Standards for Type 4 wastes.

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

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

(4) Incinerators should be located so that prevailing winds carry exhaust fumes away from dwellings.

1.3.2.7. Waste Chemicals

(1) Dangerous chemicals should be disposed of strictly in accordance with the instructions on the manufacturer's label.

SUBSECTION 1.3.3. SANITATION

1.3.3.1. Milk Production

(1) General

Dairy barns, milking parlours 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 product,

(b) have their surroundings well drained, and,

(c) conform to the requirements of local authorities for special sanitary requirements.

(2) Dairy barns

(a) General

(i) A dairy barn should house one species of animal only.

(ii) The milking parlour should be separated from an attached housing area by a full partition broken only by self-closing doors.

(iii) Storage for grain, mill feeds, hay and bedding should be provided and separated from the barn and milking area by dustproof walls and/or ceilings.

(iv) Dairy barns should be provided with adequate ventilation and lighting for the number of animals housed therein. (see Subsection 2.2.2. and Article 2.2.4.7.)

(b) Construction

(i) A dairy barn having an overhead storage space should be provided with a dustproof ceiling.

(ii) The interior walls and ceilings of rooms in which animals are milked should have finished surfaces which will permit good sanitation. Interior window sills should be flush with the window frames or sloped downward to prevent accumulation of debris.

(iii) Gutters and mangers should be concrete or other durable material finished to permit good sanitation.

(iv) Gutters, litter alley floors and feeding area floors should be paved with watertight durable materials.

(v) Floors intended for animal traffic should have a rough-textured surface to prevent slipping.

(c) Dimensions

(i) Tie stall platforms should slope to the gutter at at least ¼ in. per foot.

(ii) Litter alleys should have a minimum width of 7 ft between gutters and a minimum width of 6 ft between gutter and wall. Litter alleys should slope at least ¼ in. per foot to gutters.

(iii) Minimum gutter dimensions should be 16 in. wide and 6 in. deep.

(3) Milkhouses

(a) Location

(i) A milkhouse should not be part of a dwelling or of any 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. Openings should be fitted with a self-closing door.

(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) Where a milking parlour is an intergral part of a milkhouse, the milking parlour 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 to prevent accummulation of debris.

(c) Construction

(i) Milkhouse and milking parlour floors, and walls, to 6 in. above floor line, should be of concrete or other durable material, finished with a smooth surface throughout. The walls above this height should be clad with material which presents a hard, smooth surface and which is relatively impervious to moisture.

(ii) The foundation, walls and ceiling, should be well insulated to prevent the formation of condensation, and possible freezing conditions during cold weather.

(iii) The floors should be so constructed as to eliminate random cracking due to load or contraction.

(d) Milkhouses should be designed to permit the installation of milk cooling facilities which are approved in accordance with CSA Specification C22.2 No. 32-1954, Electrically–Operated Refrigerating Machines, and installed in accordance with Provincial regulations.

(e) A milkhouse should be supplied with potable water. (see Subsection 1.3.1.) For cleaning purposes, the milkhouse should have:

(i) a cold water hose bib,

1.3.3.1.(3)(e)

(ii) a hot water supply at 160°F for udder wash water and cleaning the milking system, (See Clause 3.2.5.1.(2)(b))

(iii) a double wash sink with mixing taps supplying hot and cold water plus a single wash sink if automatic milking cluster and milk pipeline washing is required,

(iv) drain boards, and,

(v) racks for proper storage of utensils used in the room.

(f) Drains (see Sentence 1.3.2.1.(2))

(i) Milkhouses should have a minimum of one trapped floor drain 4 in. or more in diameter plus sink drains suitably trapped.

(ii) Floor drains should be located at least 2 ft from the bulk milk tank outlet.

(iii) All drains should be suitably vented.

(g) Ventilation and lighting should be as given in Subsection 2.2.2. and Sentence 2.2.4.7.(5) respectively. Forced ventilation where provided in the milkhouse should be positive pressure.

(h) Milkhouses with bulk milk tanks

(i) A milkhouse in which a bulk milk 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 exterior 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 bulk milk tank.

(iv) The space between the top of a bulk milk tank and the ceiling of the milkhouse should be sufficient to permit removal of the tank measuring rod but in no case less than 3 ft.

(v) Space should be provided in milkhouses to permit a bulk milk 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 have passage widths of at least 2 ft around the bulk milk tank, 3 ft at the bulk milk tank outlet end, and 4 ft in front of utensil racks and wash sink.

(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 odours or to be detrimental to the quality of milk or manufactured milk products.

1.3.3.2. Contagious Disease Control Structures

These structures are designed to attempt to break the pathways along which diseases are transmitted.

(1) Special treatment and holding rooms

(a) These rooms should be constructed so as to permit ready cleaning and disinfecting.

(b) Floors should be constructed of concrete or other equivalent material coved to walls which are concrete or other equivalent material for a minimum of 12 in. above the floor level.

(c) Walls and ceilings should be constructed of materials and finished so that the surface will be smooth and nonabsorbent.

(d) Individual heating and ventilation systems should be provided.

1.3.3.3. 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) If a lavatory is constructed in the structure, it should be a separate room, properly drained and ventilated, and should have, in or adjacent to it, a hand-basin for washing.

PART 2
GOOD PRACTICE AND PERFORMANCE

This Part refers to the functional requirements of farm buildings, good construction practice and optimum conditions for efficient production and storage, and economical construction.

SECTION 2.1 SPACE ALLOWANCES

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

SUBSECTION 2.1.1. ANIMAL PRODUCTION

2.1.1.1. 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 milk cows.

(b) Using the number of milking cows as a basis, the additional animals required for replacements may be estimated as follows:

calves (0 to 3 months)	12 per cent
heifers (3 to 10 months)	20 per cent
heifers (10 months to 2 years)	35 per cent
heifers (2 years to freshening)	22 per cent
dry cows	12 per cent

(2) Tie stall barns

(a) (i) The floor to ceiling height should be a minimum clear distance of 8 ft.

(ii) Clear height from floor to overhead services should be a minimum of 6 ft 6 in.

(b) (i) Litter alleys should be 7 ft wide between gutters and 6 ft wide between gutter and wall. See also Subclause 1.3.3.1.(2) (c) (ii).

(ii) Where grate-covered gutters are used in lieu of open gutters, the combined width of litter alley and gratings should be 9 ft from stall platform to stall platform, and 7 ft from stall platforms to walls.

(c) Floor gutters should have a minimum width of 16 in., and a minimum depth of 6 in.

(d) Feed alleys for cart feeding should be:

(i) 4 ft wide with sweep in mangers

(ii) 5 ft wide with high front mangers

(iii) 6 ft wide with floor feeding, from stall front to wall

(iv) 7 ft wide floor feeding, from stall front to stall front.

(e) Mangers for milk cows should be:

(i) 20 to 24 in. wide if sweep in type

(ii) 28 in. wide if high front type.

(f) Where mechanical conveyer feeding is used without a feed alley, feeding space should be:

(i) 5 ft wide, stall front to stall front

(ii) 3 ft wide, stall front to wall.

(g) Cross alleys should be at least 4 ft wide.

(h) Stall platform dimensions for stanchion tie stalls should be as in Column 3, Table VII.

TABLE VII

DIMENSIONS FOR STANCHION TIE-STALLS FOR DAIRY CATTLE

Animal Weight, lb	Stall Platform Width	Stall Platform Length	
		Without Trainers	With Trainers
800	3 ft 4 in.	4 ft 6 in.	4 ft 10 in.
1000	3 ft 8 in.	4 ft 8 in.	5 ft 0 in.
1200	4 ft 0 in.	5 ft 0 in.	5 ft 4 in.
1400	4 ft 4 in.	5 ft 4 in.	5 ft 8 in.
1600	4 ft 8 in.	5 ft 8 in.	6 ft 0 in.
Column 1	Column 2	Column 3	Column 4

(i) For chain tie stalls, platform lengths should be as in Column 4, Table VII.

(j) For single headrail-type tie stalls, a stall platform 5 ft 6 in. long may be used for cattle ranging from 1000 to 1400 lb, by providing headrail adjustment from 2 in. to 8 in. forward of the stall-front hardware.

(3) Loose housing

(a) Manure pack resting areas should provide 60 sq ft of floor area per head for milking cows and 40 sq ft per head for dry cows and heifers. Clear height floor to ceiling should be 10 ft minimum.

(b) Free stall resting areas should have litter alley widths as in Table VIII.

TABLE VIII

LITTER ALLEY WIDTHS BETWEEN FREE STALL CURBS

Stalls per row	Alley width, ft	
	Solid Floors	Slotted Floors
up to 5	7	7
6 to 16	8	7
17 to 26	10	8
27 to 36	12	9

(c) Free stall dimensions should be as given in Table IX. An adjustable headrail as shown in Figures 1-O and 2-O, Appendix O, should span the stall dividers to accommodate variations in average group size.

TABLE IX

FREE STALL DIMENSIONS FOR DAIRY CATTLE

Cattle Housed	Stall Width	Stall Length Including Heel Curb	
		*Stalls with Earth Floor	**Stalls with Paved Elevated Floor
Yearling heifers	3 ft 0 in.	6 ft 6 in.	6 ft 3 in.
Heifers or cows, 800 lb av wt	3 ft 4 in.	7 ft 0 in.	6 ft 9 in.
Cows, 1000 lb av wt	3 ft 6 in.	7 ft 3 in.	7 ft 0 in.
Cows, 1200 lb av wt	3 ft 9 in.	7 ft 6 in.	7 ft 3 in.
Cows, 1400 lb av wt	4 ft 0 in.	8 ft 0 in.	7 ft 6 in.

Notes to Table IX:

* Refer to Figure 1-O, Appendix O

** Refer to Figure 2-O, Appendix O

(d) The exercise yard should provide:

(i) if hard surfaced: a minimum of 60 sq ft per head for milking cows, dry cows and heifers

(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.

(e) 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

(ii) if fed at time intervals: 28 in. per head for milking cows, dry cows and heifers

(iii) 30 in. width if animals feed from one side and 60 in. if animals feed from both sides.

(f) Minimum feeding area widths for cows and heifers should be 11 ft from feed bunk to wall or fence, 12 ft from feed bunk to free stall heel curb, and 16 ft from feed bunk to parallel feed bunk.

(g) Watering devices should be heated if required to prevent freezing, and should be provided at 1 sq ft of water surface per 50 head, or a minimum of one drinking unit per pen.

(h) Water and feeding facilities may be located in free stall litter alleys but not in an open pen resting area.

(4) Pens

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

(b) Calves 0 to 3 months old should have individual pens 2 ft 3 in. by 5 ft minimum.

(c) Calves over 3 months old may be housed in either individual pens or group pens. Calves housed in individual pens from 3 to 6 months old should have 3 ft by 5 ft minimum, and to 10 months, 3½ ft by 6 ft minimum.

(d) Calves 3 to 10 months old housed in group pens should have 24 sq ft per head with bedding or 16 sq ft per head with slotted floors.

(5) Holding area

(a) Where cows are milked in a milking parlour, a holding area is required, providing 15 sq ft per 1200-lb. cow. The holding area may be part of the regular animal traffic area suitably gated for separation of the cows to be milked.

(b) The holding area should be so arranged and proportioned that cows can enter the milking parlour easily and without sharp turns.

(6) Milking parlours

The following dimensions relating to milking parlour stall hardware are approximate; final dimensions should be based on the recommendations of equipment manufacturer:

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

(b) Floor slopes in operator pits should be in the direction that the operator normally faces during milking.

(c) Stalls for herringbone-type parlours should consist of approximately rectangular areas 8 ft long (including feed box) by 22 in. wide, at an angle of 35° to the operator alley. Minimum walk-through clearance between rump rail and mangers should be 2 ft 10 in.

2.1.1.1.(6)

(d) Stalls for other parlours should be 2 ft 9 in. wide, 8 ft long for side-entering and 8 ft 6 in. long for walk-through types.

(e) The cow alley should be at least 3 ft wide, increased to 4 ft at turns.

(f) The ceiling height should be at least 7 ft clear distance above stall floor. Clearance below fluorescent lights where used in animal traffic areas should be 9 ft minimum.

(g) Cow platform height should be 2 ft 6 in. (minimum) to 3 ft 0 in. (optimum) above operator floor area.

(h) Ramp slopes to and from the cow platform should not be more than 4 in. per foot and should be provided with a roughened, cleated or grooved surface.

(i) The rise of steps (where used in lieu of ramp) should be not more than 9 in. and the run should be 20 to 24 in.

(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 of hay per cow-day if no silage is fed

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

(iii) where silage and hay are fed in combination substitute at the ratio of 3 lb silage to 1 lb hay

(iv) 6 to 15 lb of concentrate per cow-day, or 1 lb concentrate per 3 lb of milk produced.

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

(c) Storage for bedding should be based on Table X and on densities for bedding materials from Appendix F, Table F-II.

TABLE X

BEDDING FOR DAIRY CATTLE

Cattle	Manure Pack Loose Housing, lb/head-day	Free Stall Loose Housing, lb/head-day	Tie Stall Housing, lb/head-day
Milk cows	15	4	8
Dry cows and heifers	8	2	4
Calves 3 to 10 mo.	3	1	2

(d) For manure storage see Sentence 2.2.6.1.(1).

2.1.1.2. Beef Cattle

(1) General

(a) Feed lots located in areas having less than 20 in. precipitation per annum may be soil surfaced, but at least a 10-ft-wide paved strip should be provided for the animal feeding area adjacent to each feed bunk. The paved strip should be included in feed lot area requirements, and should be sloped from feed bunk at least ½ in. per foot.

(b) Feed bunks should have an adjacent step 12 to 16 in. wide by 6 in. high at the animal side.

2.1.1.2.(1)

TABLE XI

ACCOMMODATIONS FOR BEEF CATTLE

Accommodation	Cows and Bred Heifers	Yearlings	500-lb Calves
Feed lot (without shed)			
hard surfaced	80 sq ft	45 sq ft	40 sq ft
soil	300 sq ft	250 sq ft	150 sq ft
Feed lot (with shed)			
lot area			
– hard surfaced	50 sq ft min.	25 sq ft min.	25 sq ft min.
– soil	300 sq ft min.	250 sq ft min.	150 sq ft min.
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.
Slotted floors			
space per animal	30 sq ft	20 sq ft	12 sq ft
% of floor area slotted	100	100	100
Maternity pens (additional area)	1 pen/20 cows 10 ft by 10 ft minimum (not slotted)		
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 bunk			
length per head			
– simultaneous feeding	2 ft 2 in.	1 ft 8 in.	1 ft 6 in.
– full feeding			
– roughage	8 in.	8 in.	6 in.
– mill feed	3 in.	3 in.	2 in.
height at throat	18 in.	18 in.	18 in.
max. reach (top of throat board to bottom inside corner)	34 in.	30 in.	24 in.
Feed storage			
hay, without silage	25 lb/head-day (maintenance only) or	15 lb/head-day (maintenance only)	12 lb/head-day (maintenance only)
silage, without hay	75 lb/head-day (maintenance only)	4½-5 lb/day per 100 lb live wt. (fattening)	35 lb/head-day (maintenance only)
grain and concentrate	Cows: no grain Fattening 2-year olds; 1½-2 lb/day per 100 lb live wt.	may substitute grain for hay at 1 lb grain per 1½ lb hay	1½-2 lb/head-day

(c) Slotted floors with shelter may be used as an alternative to surfaced or unsurfaced feed lots.

(i) Slotted floors for calves to 3 months of age should have slat and slot widths of 3 in. and ¾ in. respectively. For calves, an alternative to slotted flooring is flattened 1 by 2 in. expanded metal mesh.

(ii) Slotted floors for beef cattle over 3 months of age (300 lb) should have slat and slot widths of 5 in. and 1½ in. respectively.

(d) For manure storage requirements, see Sentence 2.2.6.1.(1).

(2) Accommodations for beef cattle should be as shown in Table XI.

(3) For dairy beef calves see Clauses 2.1.1.1. (4)(b), (c), and (d).

2.1.1.3. Sheep

(1) Accommodations for sheep should be as shown in Table XII.

(2) For manure storage see Sentence 2.2.6.1.(1).

TABLE XII
ACCOMMODATIONS FOR SHEEP

Accommodation	Ewes or Rams	Feeder Lambs
Feed lot		
hard surfaced	15 sq ft per head	6 sq ft per head
soil	30 sq ft per head	12 sq ft per head
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.	⅝ in.
slat width	2 to 3 in.	2 to 3 in.
Lambing pen (not slotted)		
floor area	16 sq ft	
Feed rack**		
length per head	16 in. group feeding 6 in. self-fed	12 in. group feeding 4 in. self-fed
height at throat	12 in. small breeds 15 in. large breeds	10 in. small breeds 12 in. large breeds
Feed storage		
hay	3 lb/head-day	½ lb/head-day
grain	⅓ lb/head-day	⅔ lb/head-day
Bedding storage	¾ lb/head-day	¼ lb/head-day
Water		
surface area	1 sq ft/40 head	1 sq ft/40 head

Notes to Table XII:

* An alternative to slotted floors, for ewes, rams or lambs is 1 by 2 in. 10-gauge expanded and flattened metal mesh. Expanded metal mesh floors may be covered with a solid panel to retain bedding for lambing.

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

2.1.1.4. **Swine**

(1) Accommodations for swine should be as shown in Table XIII.

TABLE XIII
ACCOMMODATIONS FOR SWINE

Accommodation	Sows	Weaners (under 50 lb)	Feeders (50-200 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
Confinement housing			
Solid floor pen area	20 sq ft per sow under 400 lb	4 sq ft per pig	6 sq ft per pig under 100 lb
	24 sq ft per sow over 400 lb		8 sq ft per pig 100 to 200 lb
Slotted floor pens			
total pen floor area	16 sq ft per sow under 400 lb	3 sq ft per pig	4 sq ft per pig 50 to 100 lb
	20 sq ft per sow over 400 lb		6 sq ft per pig 100 to 150 lb
			8 sq ft per pig 150 to 200 lb
slotted floor area	*35 to 100% of pen	*30 to 100% of pen	*30 to 100% of pen
slot width	1 to 1¼ in.	**¾ to 1 in.	1 to 1¼ in.
slat width	1½ to 5 in.	1½ to 5 in.	1½ to 5 in.
Partition height	3½ ft	2 ft	2 ft 8 in. (open) 3 ft 0 in. (solid)
Self-feeder length	(not recommended)	2 in. per pig	3 in. per pig
Feed trough length	1½ ft per sow	10 in. per pig	13 in. per pig
Individual feeding stalls	1½ ft wide, 2 to 6 ft long		13 in. x 5 ft
Gestation tie stalls			
width	2 to 2 ⅓ ft		
length, feed trough to gutter	***5 to 5½ ft		
to slotted floor	4 ft		
Gestation pen stalls			
width	2 ft 2 in.		
length	6 ft		
height	3½ ft		
Farrowing pens			
side creeps, early weaning (4 weeks)	****5 by 7½ ft		
side creeps, late weaning (6 to 7 weeks)	6 by 7½ ft		
front creep	5 by 9½ ft		
clearance under creep partitions	8 to 10 in.		

(Continued next page)

TABLE XIII (Cont'd.)

Accommodation	Sows	Weaners (under 50 lb)	Feeders (50-200 lb)
Water	1 watering cup per 15 sows or minimum of 1 per pen	1 watering cup per 25 pigs or minimum of 1 per pen 600 lb feed from birth to 200 lb	1 watering cup per 20 pigs or minimum of 1 per pen
Feed	1 ton per sow per year	600 lb birth to 200 lb	

Notes to Table XIII:

* For pen floors partly slotted, slotted floor may be 1½ in. below adjacent solid floor.

** For weaner pens, an alternative to slotted floors is 9-gauge expanded and flattened steel mesh, ¾ by 2 in. o.c. mesh size. Floor area adjacent to the self-feeder may be covered with a solid panel to conserve feed and to provide a sleeping platform.

*** For sows tail-to-tail in 2 rows, with a single shallow gutter or slotted floor between, allow a minimum of 13-ft total, excluding feed troughs.

**** 5 ft minimum pen width is sum of 2-ft heated feeding creep, 2-ft sow space, and 1-ft unheated creep.

2.1.1.5. Horses

(1) Accommodations for horses should be as shown in Table XIV.

TABLE XIV

ACCOMMODATIONS FOR HORSES

Accommodation	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 by 10 ft	12 ft by 14 ft	8 ft by 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 by 2 ft	1 ft by 2 ft	1 ft 6 in. by 10 in.
Feed storage (per year)			
hay	2 tons per horse	2 tons	1 ton
grain	40 bushels	80 bushels	30 bushels

(2) For manure storage, see Sentence 2.2.6.1.(1).

2.1.1.6. Chickens

(1) Floor housing for laying hens and of breeding flocks should be as shown in Table XV.

2.1.1.6.

(2) Requirements for birds confined in cages depend on the size and type of cage used, and the number of birds in each cage. Minimum cage floor area for egg strain layers should be 0.5 sq ft per bird for 2 or more birds per cage; for single bird cages minimum cage floor area should be 0.9 sq ft.

(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 32-in. minimum clear hallway width should be provided between rows of combined cages and at outside along walls.

(3) Egg Holding and Egg Grading Rooms

(a) The floors in egg holding and grading rooms should be constructed of concrete or equivalent material finished with a smooth surface throughout, and should be sloped to a suitably trapped drain.

(b) Ventilation and refrigeration should be provided in egg holding rooms. Where egg holding rooms have walls and ceiling exposed to outside temperatures, supplementary heating may also be required.

(c) Ventilation and heating should be provided in egg grading rooms.

TABLE XV

FLOOR HOUSING FOR LAYING HENS AND BREEDING FLOCKS

Accommodation	Floor System		
	Deep Litter Floor dropping pits, under roosts	Combination 1/2-2/3 Wire or Slat Floor, 1/2-1/3 Deep-Litter Floor	Complete Wire or Slat Floor
Floor area per hen egg-strain breeds heavy breeds (over 5 lb)	 2 sq ft 3 sq ft	 1.25 sq ft 2 sq ft	 1.25 sq ft
Feeding space per 100 hens	If hand fed, 20 ft of double-sided troughs or 4 round hanging feeders (pan diameter 16 in.). For automatic feeding, reduce feeding space 50 per cent.		
Watering space per 100 hens	2 watering cups, 2 five-gallon fountains or 60 linear in. of drinking troughs.		
Nesting space per 100 hens	20 nests, 10 in. by 12 in. by 13 in. high for both light and heavy breeds or one community nest 2 ft by 8 ft.		

(4) The requirements for the growing of broilers, roasters and replacement pullets should be as shown in Table XVI. Broilers are normally marketed in 8 to 9 weeks and roasters in 12 to 14 weeks.

2.1.1.6.

TABLE XVI
REQUIREMENTS FOR THE GROWING OF CHICKEN BROILERS, ROASTERS AND REPLACEMENT PULLETS ON FLOOR SYSTEMS

Accommodation	Age, weeks			
	0-2	3-6	7-10	11-20
Floor area *per bird (sq ft)	0.5	0.75	0.75	1.5(light breed) 2.0(meat breed)
Length **of feed space per bird (in.)	1	2	3	3
Watering space **for 100 birds	2 fountains at 1 gal. each	automatic troughs, 60 linear in. or 2 fountains at 3 gal. each	automatic troughs, 60 linear in. or 2 fountains at 3 gal. each	100 linear in.
Brooding requirements Warm room brooding (60°F min.)	*** 0.05 sq ft/chick usable floor under canopy brooder, to 4 or 5 weeks or 125 chicks/250-watt heat lamp or equivalent to 4 or 5 weeks			
Cold room brooding	*** 0.10 sq ft/chick under canopy brooder, to 8 or 10 weeks or 70 chicks/250-watt lamp or equivalent, to 8 or 10 weeks			
Roosting requirements		If roosts are used, 0.25 ft/ bird	If roosts are used, 0.45 ft/ bird (light breeds) 0.5 ft/ bird (heavy breeds, except broilers)	

Notes to Table XVI:

* 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 of time birds are removed.

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

*** Ewing, W.R. Handbook of Poultry Nutrition, Section 767, p. 1114. Published by W.R. Ewing, S. Pasadena, Cal., U.S.A.

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

(6) The capacity of on farm bulk feed storage for any one feed mix should be based on a minimum delivery of 3 tons, and a maximum holding time of 4 weeks.

(7) For manure storage, see Sentence 2.2.6.1.(1).

2.1.1.6.

TABLE XVII

CUMULATIVE FEED REQUIREMENTS FOR GROWING CHICKENS

Age, weeks	Cumulative feed requirements, lb/bird			
	Broilers	Roasters	Replacement Pullets	
			Egg Strain	Meat Strain
2	.72	.74	.4	.5
4	2.39	2.58	1.3	1.7
6	4.93	5.33	2.4	3.5
8	8.29	8.96	3.8	5.7
9	10.22	–	–	–
10	–	13.11	5.6	8.2
12	–	17.08	7.6	11.0
14	–	20.60	9.7	14.0
16	–	–	11.9	17.2
18	–	–	14.2	20.6
20	–	–	16.6	24.0
22	–	–	19.1	27.6
24	–	–	21.7	31.3

TABLE XVIII

FEED REQUIREMENTS FOR LAYING HENS

Type of Bird	Average Feed Consumption lb/bird-day
Light Breeds	0.25
Meat Breeds	0.35

2.1.1.7. Turkeys

(1) Accommodations for turkey breeding flocks should be as shown in Table XIX.

TABLE XIX

ACCOMMODATIONS FOR TURKEY BREEDING FLOCKS

Accommodation	Requirements	
Floor area, per bird		
small breeds	6 sq ft	
large breeds	8 sq ft	
Feed space, per bird	3 linear in.	
Watering space, per bird	1.5 linear in.	
Nest space, per 3 hens	1 nest – 14 in. by 24 in. by 24 in.	
Feed Consumption, per bird-day	Broiler Strain	Heavy Strain
toms	0.75 lb	1.0 lb
hens	0.5 lb	0.75 lb
Broody Space*	0.5 sq in. of wire floor, no bedding well lighted	

Notes to Table XIX:

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

2.1.1.7.

(2) The space requirements for brooding heavy 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 4 sq ft per bird should be provided.

(c) The feed space per bird should be increased from 2 in. at 2 weeks to 3 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.

(3)

(a) The space requirements for brooding medium white turkey poults should be as follows:

0-14 weeks	0.8 sq ft each
Over 14 weeks	1.75 sq ft each

(b) The feed and water space should be the same as for heavy turkey poults.

(4) For manure storage see Sentence 2.2.6.1.(1).

(5) Cumulative feed requirements for growing turkeys are given in Table XX.

TABLE XX

CUMULATIVE FEED REQUIREMENTS FOR GROWING TURKEYS

Cumulative feed requirements, lb/bird				
Age, weeks	Turkey Broilers (Mixed Sexes)	Broilers (Hens)	Large White Turkeys	
			Hens	Toms
2	0.65	0.61	0.50	0.50
4	1.79	2.08	1.98	2.30
6	4.38	5.04	5.01	5.51
8	7.26	8.59	8.96	10.19
10	11.64	13.86	13.26	16.43
12	16.75	20.02	18.01	23.62
14	22.57	26.66	24.01	32.72
16	–	–	30.12	42.48
18	–	–	37.37	52.87
20	–	–	48.35	65.04
22	–	–	57.17	78.34
24	–	–	–	91.93

2.1.1.8. Fur-bearing Animals

(1) Mink

(a) Buildings for housing mink should:

(i) be located on ground which has good water drainage both surface and subdrainage,

(ii) be located where snowdrifting does not create problems, and

(iii) have earthen floors bedded slightly to facilitate dropping removal.

(b) 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.

(c) The structures should be surrounded by a guard fence designed to exclude other animals.

(d) A feed room should:

(i) be attached directly to the compound,

(ii) have a refrigeration room for minus twenty-degree freezing of feed, together with portion for zero-degree holding, and

(iii) include a grinding and mixing room.

(e) A pelting room should be provided for killing, cooling, pelting, fleshing, cleaning and stretching of the fur product.

(f) The breeder pen for confinement of the bred female and her kits should be 18 in. wide by 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.

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

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

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

(j) 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 by 7 ft by 3 ft high with the pen bottom elevated 2 ft above grade.

(3) Rabbits

(a) Buildings for the housing of rabbits for meat production should be insulated and equipped with mechanical ventilation for the control of environmental temperature and humidity.

(b) Rabbit cages

(i) One doe cage 36 in. by 30 in. by 18 in. should be provided for each doe in the herd.

(ii) One buck cage having the same dimensions as a doe cage should be provided for each 10 to 12 doe cages.

(iii) One fryer cage, 36 in. by 30 in. by 12 in. should be provided for each 2 doe cages.

(iv) Cages should be constructed of welded galvanized wire or equivalent as follows: bottoms – ½ in. by 1 in., 14/14 gauge, fronts – 1 in. by 1 in., 14/14 gauge, remaining parts – 1 in. by 1 in., 16/16 gauge.

(v) Nest boxes for doe cages should be wooden open topped, and be at least 19 in. long, 12 in. wide and 9 in. deep, outside dimensions, and may have a 6-in. wide opening in one end. Bottom of opening should be 6 in. above cage floor.

2.1.1.8.(3)(c)

(c) Cage arrangement

(i) Cages are normally arranged with 2 doe cages stacked above one fryer cage with 5-in. vertical clearance between cages for dropping trays. Floor of the fryer cage is normally 18 in. above the passage floor.

(ii) Cages should be arranged in back to back rows, with up to 24-in. clearance provided between the backs of the cages for manure removal, cage servicing, etc.

(iii) Minimum clear width of feed passages between the cage rows should be 40 in.

(iv) Cross alleys at the end of cage rows should be at least 4 ft.

(d) Feeding and watering devices

(i) A self-feeding hopper with capacity for 15 oz. of pelleted feed should be provided for each cage. The hopper lip should be 4 in. above the floor of the cage.

(ii) One watering device per cage should be provided. If gravity supply drippers are used, they should be placed 7 in. to 9 in. above the cage floor and just outside the rear wall of the cage.

(e) Floor gutters for droppings should be provided under the cage rows and extend 3 in. beyond the front of the cages. For liquid flushing, gutters should be 10 in. deep with sides sloping from the feed passage to a 24-in.-wide flat bottom in the gutter. Gutters should be sloped slightly to outlet at the end.

(f) Feed requirements

(i) Provide storage based on 100 lb of prepared feed per doe and litter. Assume 4 to 5 litters per year with average litter size of 8.

(ii) Provide storage based on 10 lb of prepared feed per buck per month.

(g) Utility area

Additional areas should be provided for cage repairing and for cleaning and disinfecting such equipment as feed hoppers, watering equipment, and nest boxes.

(h) Isolation area

An isolation area should be provided to house 5 to 10 per cent of herd. (See Article 1.3.3.2.)

(i) For manure storage, see Sentence 2.2.6.1.(1).

SUBSECTION 2.1.2. PLANT PRODUCTION

2.1.2.1. Greenhouses

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

2.1.2.1.

TABLE XXI

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

SUBSECTION 2.1.3. PRODUCT STORAGE

This Subsection deals with the dimensions of buildings based on the requirements of the products to be stored (see Appendix F, Table F-II for unit weights of various agricultural materials).

2.1.3.1. Corn Storage in Cribs

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

(2) For circular cribs greater than 5 ft in diameter, a vertical centre duct of 2 ft is required, and the maximum space between the centre duct and the outside of the bin should not exceed 5 ft.

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

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

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

2.1.3.2. 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 hr. a day.

2.1.3.2.(1)

(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.

(f) Horizontal silos should face south, and the floor should slope south at 1 ft in 100 ft.

(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 in. per day in cool weather and 3 vertical in. per day in warm weather. (See Appendix F, Table F-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 10 per cent 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.

2.1.3.3. Potato Storage

(1) Space requirements for potato storage should be based on 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.

SUBSECTION 2.1.4. PROCESSING

2.1.4.1. 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 XXII.

(b) Pack barns

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

2.1.4.1.(1)(b)

TABLE XXII
DIMENSIONS OF TOBACCO KILNS

Measurements	Dimensions
Outside Horizontal	22 ft 6 in. wide by 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 9 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.

(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 sidewall 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.

2.1.4.2. Honey

(1) Processing Structures

(a) The structure should provide space for all equipment including extractors, pumps, tanks, uncapping machines, remelting equipment, storage of supers, and containers.

(b) The structure should incorporate washing facilities and suitable drainage, properly trapped to permit the maintenance of sanitary conditions.

SUBSECTION 2.1.5. SERVICE

2.1.5.1. 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 G.

(2) Door openings should be at least 12 in. wider and 4 in. higher than machine transport dimensions as given in Table G-I, Appendix G.

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

(4) Where doors are at ends only the span of the building should be 2.5 times the door width as given in Sentence 2.1.5.1.(2).

(5) Where the maintenance shop area can be used for vehicle storage and where this area meets the requirements of Article 2.1.5.2., up to 50 per cent of the maintenance shop floor area may be counted as storage area for self-propelled farm equipment and vehicles.

2.1.5.2. Maintenance Shops

(1) The maintenance shop floor area should be not less than 20 per cent of the area indicated for vehicle and equipment storage, be not less than 400 sq ft, and have a minimum horizontal inside dimension of 12 ft.

SECTION 2.2 ENVIRONMENTAL SERVICES

SUBSECTION 2.2.1. TEMPERATURE AND HUMIDITY

2.2.1.1.(1) The operating temperatures and relative humidities for animal production buildings should be maintained within the limits shown in Table XXIII. For effect of temperature on performance see Appendix I.

TABLE XXIII
RECOMMENDED TEMPERATURE AND HUMIDITY LIMITS FOR CLOSED ANIMAL PRODUCTION BUILDINGS*

Class of Livestock	Inside Temp., °F. Recommended Range**		Inside Relative Humidity, % Recommended Range	
Dairy cattle				
cows	20	75	25	75
calves	50	80	25	75
calves – 6 wks.	0 (if draft-free)	80		
Beef cattle	0	80	25	75
Sheep and goats	0	80	50	75
Swine				
breeders	45	70	50	75
finishers	60	70	50	75
piglets	70	90	50	75
Poultry				
chicks (1st week)	85	95	50	75
hens	20	85	50	75
turkeys	50	70	50	75
Rabbits	20	85	50	75
Horses	20	85	25	75

Notes to Table XXIII:

* D. Sainsbury, 1967 (see Bibliography)

** Lower temperatures may be tolerated but usually results in increased feed consumption. At temperatures below 32°F freezing of services must be prevented.

(2) Recommendations for environmental conditions and expected storage life for fruits, vegetables and eggs are shown in Table XXIV. These values do not necessarily apply to controlled atmosphere storage.

TABLE XXIV

STORAGE LIFE EXPECTANCIES, RECOMMENDED STORAGE TEMPERATURES AND RELATIVE HUMIDITIES, AND THE HIGHEST FREEZING POINTS OF FRUITS, VEGETABLES AND EGGS.

Fruits, Vegetables and Eggs	Temperature, °F	Relative Humidity, %	Approximate Length of Storage period	Highest Freezing Point, °F
Apples (for CA storage, see Table XXV)	30 to 32	85 to 95	2 wks to 7 mo. depending on variety	28.9
Apricots	31 to 32	85 to 90	1 to 2 weeks	30.1
Blackberries	31 to 32	85 to 90	Few days	30.5
Cherries				
sweet	31 to 32	85 to 90	10 days to 2 wks	28.8
sour	31 to 32	85 to 90	few days	29.0
Cranberries	36 to 40	80 to 85	3 months	30.4
Grapes (American)	31 to 32	85 to 90	4 weeks	29.7
Peaches	31 to 32	85 to 90	2 weeks	30.3
Pears				
Bartlett	30 to 31	85 to 90	2 to 3 months	28.6
fall and winter varieties	30 to 31	85 to 90	2 to 6 months depending on variety	29.2
Plums, including prunes	31 to 32	85 to 90	Prunes 4 to 6 wks. Plums 2 to 4 wks. depending on variety	29.7
Raspberries	31 to 32	85 to 90	few days	30.0
Strawberries	31 to 32	85 to 90	5 to 10 days	30.6
Asparagus	32	95	3 weeks	30.9
Beans				
green or snap	45 to 50	85 to 90	8 to 10 days	30.7
lima				
shelled	32	85 to 90	2 weeks	31.0
unshelled	32	85 to 90	2 weeks	30.9
Beets				
bunched	32	90 to 95	10 to 14 days	31.3 (tops)
topped	32	90 to 95	1 to 3 months	30.3
Broccoli (Italian or sprouting)	32	90 to 95	1 week	30.9
Brussels sprouts	32	90 to 95	3 to 4 weeks	30.5
Cabbage				
early	32	90 to 95	3 to 4 weeks	30.4
late	32	90 to 95	3 to 4 months	31.7
Carrots				
bunched	32 to 34	95	2 weeks	
topped	32 to 34	95	4 to 5 months	29.5
Cauliflower	32	90 to 95	2 weeks	30.6
Celery	33	95+	3 months	31.6

TABLE XXIV (Cont'd)

Fruits, Vegetables and Eggs	Temperature, °F	Relative Humidity, %	Approximate Length of Storage period	Highest Freezing Point, °F
Corn, sweet	32	90 to 95	8 days	30.9
Cucumbers	45 to 50	95	10 to 14 days	31.1
Eggplants	45 to 50	85 to 90	10 days	30.6
Endive or escarole	32	90 to 95	2 to 3 weeks	31.4
Garlic, dry	32	70 to 75	6 to 8 months	30.5
Horseradish	30 to 32	90 to 95	10 to 12 months	28.7
Kohlrabi	32	90 to 95	2 to 4 weeks	30.2
Leeks, green	32	90 to 95	1 to 3 months	30.7
Lettuce	32	95	Head lettuce 2 to 3 weeks	31.7
Melons or cantaloupe				
muskmelon	32 and 45	85 to 90	2 weeks	30.5
honeydew	45 to 50	85 to 90	2 to 3 weeks	30.1
watermelons	36 to 40	85 to 90	2 to 3 weeks	31.3
Mushrooms, cultivated	32	85 to 90	5 days	30.4
Onion sets	32	70 to 75	5 to 7 months	
Onions, dry	32	50 to 70	5 to 9 months	30.4
Parsnips	32	95	2 to 4 months	30.4
Peas, green	32	95	1 to 2 weeks	29.9
Peppers, sweet	45 to 50	85 to 90	8 to 10 days	30.7
Potatoes, (early)				
1. Table	50	85 to 90	few days to several weeks	30.3
2. Processing	60 to 70	85 to 90	few days to several weeks	30.3
Potatoes (late)				
1. Table*	45 to 50	85 to 90	4 to 9 months depending on variety	30.3
2. Seed	36 to 38	85 to 90	7 to 8 months	30.3
3. Chips*	50	85 to 90	8 to 10 months	30.3
4. French fries	40 to 45	85 to 90	8 to 10 months	30.3
Pumpkins	44 to 50	70 to 75	2 to 3 months	30.5
Radish				
spring, bunched	32	90 to 95	2 weeks	31.3
winter	32	90 to 95	2 to 4 months	30.7
Rhubarb	32	90 to 95	2 to 3 weeks	30.3
Rutabaga or turnip	32	90 to 95	6 months	30.1
Salsify	32	90 to 95	2 to 4 months	30.4
Spinach	32	90 to 95	10 to 14 days	31.5
Squash				
summer	44 to 50	70 to 75	2 weeks	31.1
winter	44 to 50	70 to 75	6 months	30.7
Sweet potatoes				30.1
Tomatoes				
ripe	50	85 to 90	3 to 5 days	31.1
mature green	55 to 60	85 to 90	2 to 6 weeks	30.5
Eggs	50 to 60	60 to 65		

Note to Table XXIV:

* plus sprout inhibitor

2.2.1.1.

(3) Apples held in controlled atmosphere storage should be stored under conditions of temperature and gaseous concentrations shown in Table XXV.

TABLE XXV
CONTROLLED ATMOSPHERE STORAGE REQUIREMENTS FOR SOME VARIETIES OF APPLES*

Variety	Storage Temperature		Carbon Dioxide %	Oxygen %	Storage Relative Humidity %
	Min. °F	Max. °F			
McIntosh	35	38	5	3	95
Delicious	30	32	2.5	3	95
Golden Delicious	32	–	2.5	3	95
Rome Beauty	32	–	2.5	3	95
Northern Spy	32	35	5	3	95
Winesap	32	–	5	3	95
Spartan	30	–	2.5	3	95
Newton	35	–	3	3	95
Jonathan	32	–	4	3	95
Baldwin	32	–	2.5	3	95
Macoun	38	–	5	3	95

Note to Table XXV:
* Handbook on the storage of fruits and vegetables, Canada Dept. of Agriculture, 1967 (see Bibliography).

(4) 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 (to heal) at higher temperatures.

(5) Building surfaces should be provided with sufficient insulation and/or air circulation to prevent condensation under the outside design temperatures and recommended inside humidities.

SUBSECTION 2.2.2. VENTILATION

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

2.2.2.1. General

(1) The outside winter design temperatures for ventilating should be determined on a 5 per cent basis (see Figure 1-H, Appendix H for map of Canada showing January design temperature).

Winter design temperature (5 per cent basis) is the temperature value expressed in degrees Fahrenheit at or below which 5 per cent of the January hourly outdoor temperatures occur.

(2) Inside design temperatures for product storage should be based on Table XXIV.

(3) Inside design temperatures for livestock should be based on optimum conditions indicated in Appendix I.

2.2.2.1.

(4) 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 I)

(5) 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 J)

(6) 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 square foot of greenhouse floor area plus evaporative cooling.

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

2.2.2.2. Ventilation Systems

(1) All ventilating equipment should be CSA approved, all motors totally enclosed and installed in accordance with Provincial electrical codes.

(2) Design of ducts, air inlets, grilles, fans and power units should be carried out in accordance with good engineering practice. (See Figures 1-K and 2-K, Appendix K, for resistance of grains and seeds to air flow; see Figures 3-K to 7-K, Appendix K, for duct resistance.)

(3) Exhaust fans that are not connected to a duct system should be selected on the basis of delivery at not less than 1/8-in. water static pressure.

(4) A warning device should be installed in the system to detect ventilation failure.

(5) Shutters should be provided on exhaust fans.

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

(7) 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.

(8) Fresh air inlets should be arranged to prevent direct drafts on livestock in winter.

(9) Fresh air inlets should be shielded from snow and rain and should be fitted with a corrosion-resistant screen ½ in. sq. mesh.

(10) Fresh air inlets should be separated from exhaust fans by at least 10 ft. Inlets should provide even distribution of fresh air to all parts of the building.

(11) For machine repair shops, see Sentence 1.2.5.9.(2)

SUBSECTION 2.2.3. HEATING AND REFRIGERATION SYSTEMS

2.2.3.1. General

For approval and installation specifications for heating and refrigeration equipment see Sentence 1.2.2.1.(1).

2.2.3.2. Heating Systems

(1) Sufficient insulation should be provided in accordance with Subsection 2.3.4. 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) Except for CO_2 controlled atmospheres, when fuels are burned in greenhouses fresh air inlets should be provided at the rate of 50 sq in. for every 100,000 Btu of fuel input.

2.2.3.3. Refrigeration Systems

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, heat gain and losses from other sources, and relative humidity.

SUBSECTION 2.2.4. ELECTRICAL SERVICES

2.2.4.1. General

All buildings should be served from a stepdown transformer located centrally in relation to the electrical loading.

2.2.4.2. For size of service see Article 1.2.3.2.

2.2.4.3. Three-phase Power

In areas where three-phase power is not readily available, three-phase motors from 7.5 to 50 horsepower may be supplied by means of a phase convertor. *"Phase convertor" means a device that will permit the operation of a three-phase induction motor from a single-phase power source.* Consult power supply authority as to size allowed in a particular location.

2.2.4.4. Isolated motors and electrical equipment

Motors and electrical equipment located a considerable distance from the farm buildings may be served by a separate service or by a circuit from the farm service.

2.2.4.5. General Requirements for Lighting and Cable Heating

(1) Lighting recommendations in this Subsection are based on the use of concentrated light sources, such as incandescent lamps. For fluorescent lighting, the outlets should be located to suit the installation planned.

(2) Cable heating recommendations in this Subsection are based on density in watts per sq. ft. (See Article 1.2.3.12. and Table L-VII and Figure 1-L, Appendix L.

2.2.4.6. Branch Circuits

(1) Types of circuits

(a) *"General use branch circuit" means that portion of the wiring system extending from the final fuse or circuit breaker to the outlets such as lighting and general purpose convenience outlets.* Table L-III in Appendix L should be used for design base load on ¾ ampere per outlet.

(b) *"Individual use branch circuit" means a circuit installed to supply individual equipment such as a motor, ½-horsepower or over, a stationary appliance of 1000 watts or over, poultry brooders and heating equipment.* Special and individual use circuits should be designed in accordance with Article 1.2.3.2. No. 12 AWG copper wire is the recommended minimum size for individual or special circuits.

2.2.4.7. Dairy Structure

(1) Tie-stall dairy barns

(a) Lighting outlets

(i) Litter alleys – for face-out arrangement, place lighting outlets along the centre line of the litter alley, one outlet directly behind every other stall divider. For wide litter alleys use two rows of outlets 12 in. to rear of each gutter line, locating outlets alternately across the alley.

For face-in arrangement place lighting outlets about 12 in. to rear of gutter line, directly behind every other stall divider.

(ii) One outlet should be provided every 10 to 12 ft of feed alley.

(iii) 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.

(b) Convenience outlets

(i) A convenience outlet should be installed at least every 50 ft along litter alleys. These outlets may be on outside walls where cows face in and on structural posts where cows face out.

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

(c) Special-purpose outlets

(i) Circuit using a minimum of No. 12 AWG wire should be provided for vacuum pump for milking machine, refrigeration compressor, and feed handling equipment.

(ii) Provide circuit for gutter cleaners. The circuit wire size, based on the motor horsepower, should be selected from Tables L-IV or L-V in Appendix L.

(iii) Ventilating fans (see Article 1.2.3.9.).

(2) Loose housing dairy barns

(a) Lighting outlets

(i) In pens with open fronts provide one lighting outlet for every 400 sq ft. In closed pens provide one lighting outlet for every 200 sq ft.

(b) Convenience outlets

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

(ii) Provide an outlet on an inside wall near each major entrance.

(iii) One outlet out to reach of animals should be provided for each maternity pen. Additional outlets should be provided in calf pen area.

(c) Special-purpose outlets

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

(ii) Separate outlets should be provided for feed handling equipment.

(3) Free stall barns

(a) Lighting outlets

Provide lighting outlets over passageways 12 ft on centre and as required to facilitate chores. Install lighting outlet over feed bunk 12 ft on centre. Control every third light in a separate group for all-night feeding.

(b) Convenience outlets

(i) Install one outlet on inside wall near each major entrance, 6 ft above floor.

(ii) Provide an outlet for clippers and veterinary equipment in treatment area.

(c) Special purpose outlets

(i) Provide circuit for electrically heated automatic watering equipment in areas where freezing is apt to occur.

(ii) Provide individual circuits for feeding equipment.

(iii) Circuits may be required for a gutter cleaner and liquid manure pump.

(iv) Provide circuits to serve heating equipment such as heating cable in pit floor, infra red or fan-forced units as required.

(v) Provide circuit for vacuum pump(s).

(4) Milking parlour

(a) Lighting outlets

(i) One outlet should be provided over the milking pit opposite the rear of each cow on the centre line of the pit, or a minimum of one outlet for each 36 sq ft of working area.

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

(b) Convenience outlets

One outlet at each end of the operator's pit should be provided.

(c) Electric heating

(i) Separate radiant heater or heat lamps may be installed over work areas for operator comfort.

(ii) Cable heating (see Sentence 2.2.4.5.(2)).

(5) Milkhouses

(a) Lighting outlets

(i) One outlet should be placed in the ceiling and one or two outlets over each work area for bulk milk tanks (see Subclause 1.3.3.1.(3)(h)(ii)).

(ii) A minimum of 2 watts per square foot (incandescent) of floor area should be provided.

(b) Convenience outlets

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

(ii) The outlets should be placed high enough to escape being splashed.

(c) Special purpose outlets

230-volt individual circuits should be provided for:

(i) Water heaters.

(ii) Milkroom heaters (if electrical).

(iii) Coolers.

(iv) Vacuum pumps (milker).

(v) Tank truck pump outlet, if required, (to be located on the outside wall near the hose port; to be controlled by a switch on the inside near the bulk tank truck outlet).

(d) Electric heating (if used)

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

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

(iii) Electric cable heating (see Sentence 2.2.4.5.(2)).

(e) Ventilating fans (see Article 1.2.3.9.).

2.2.4.8. Beef Cattle Structure

(1) Beef barns

(a) Lighting outlets

(i) Provide one outlet for every 400 sq ft of open front pen area and one outlet for every 200 sq ft of closed pen area.

(ii) Provide one outlet for every 100 sq ft in feed rooms and power equipment control areas.

(iii) Provide one outlet over maternity and bull pens and one outlet with wall-switch control outside the pens.

(iv) Provide outlets over feed bunks and feeding areas on 15-ft centres with every third outlet separately switched as a group for all night feeding, as required.

(v) Provide one outlet over each automatic waterer for all night use.

(b) Convenience outlet

Provide outlet in treatment area.

(c) Special purpose outlets

(i) Outlets should be provided for feed handling equipment, concentrate conveyors, bale elevators.

(ii) Outlets should be provided for automatic livestock water bowls having electrical frost protection.

2.2.4.9. Horse Structures

(1) Horse stables (tie stalls)

(a) Lighting outlets

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

(ii) One outlet should be provided for every 16 ft on centre line of the feed alley.

(iii) One outlet should be provided for each feed room and box stall.

(b) Convenience outlets

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

(ii) In barns having a centre litter alley, one outlet will serve two to four stalls depending upon the structure.

(iii) Ventilating fans (see Article 1.2.3.9.).

(iv) One outlet should be provided for each harness room and feed room.

(2) Horse stables (box stalls)

(a) Lighting outlets

(i) One outlet should be provided every 16 ft on centre line of feed alleys.

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

(iii) One outlet should be provided for each harness room and feed room.

(b) Convenience outlets

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

(ii) Ventilating fans (see Article 1.2.3.9.).

(iii) One outlet should be provided for each harness room and feed room.

(c) Special purpose outlets

(i) A special outlet should be provided, if required, for an oat crusher or roller mill in a feed room or feed cooker.

2.2.4.10. Sheep Structures

(1) **Sheep barns and lambing sheds**

(a) Lighting outlets

One outlet should be provided for every 16 ft on centre line feed alley.

(b) Convenience outlets

(i) One outlet should be provided for each pair of pens for heat lamps.

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

(iii) Ventilating fans (see Article 1.2.3.9.).

(c) Special purpose outlets

(i) Outlets should be provided for automatic livestock water bowls having electrical frost protection.

(ii) Provide outlets in tack or harness rooms if electric heat is to be used.

2.2.4.11. Hog Structures

(1) **Farrowing barns**

(a) Lighting outlets

(i) Provide outlet over every other pen partition or over centre line of farrowing crate on 10-ft centres.

(ii) Provide one outlet for each 100 sq ft of feed, isolation and wash area.

(b) Convenience outlets

(i) Provide one outlet over the creep area for each pen or farrowing crate or one duplex outlet centred over the partition dividing two adjacent creep areas. For farrowing pens with creep at head an additional outlet should be provided over the rear of the pen.

(ii) Provide one outlet located on inside wall at each main entrance.

(iii) Provide outlet in wash area.

(c) Special purpose outlets

(i) Provide circuits for each heating cable and space heaters, if electric, as required (see Sentence 2.2.4.5.(2)).

(ii) Provide outlet for water heater, if electric.

(iii) Ventilating fans (see Article 1.2.3.9.).

2.2.4.11.

(2) Hog finishing barns

(a) Lighting outlets

(i) Provide one outlet for every two pens or 200 sq ft of floor area.

(ii) Provide one outlet for each 100 sq ft of feed preparation area and isolation area.

(b) Convenience outlets

(i) Provide outlet on inside wall beside each main entrance.

(ii) Provide one outlet in isolation area for heat lamp use.

(c) Special purpose outlets

(i) Provide circuit for feed handling equipment.

(ii) Provide circuits for floor heat if required (see Sentence 2.2.4.5.(2)).

(iii) Ventilation fans (see Article 1.2.3.9.).

2.2.4.12. Poultry Structures

(1) Laying houses

(a) Lighting outlets

(i) Birds on litter, slats or wire

Provide ceiling outlet 12 ft on centre. In addition, provide a 10-watt dim-light outlet for each 400 sq ft of floor area on separate circuit, in a row, slightly back of bright light outlets towards roosts. Control both bright and dim-light outlets by wall switches and time clocks.

(ii) Birds in cages

Provide outlets every 12 ft on centre line of aisles between double-tier cages and every 10 ft on centre line of aisles between triple-tier cages controlled by wall switches and time clock.

(iii) Provide one outlet for every 100 sq ft of feed and preparation area.

(b) Convenience outlet

(i) Floor housing

Provide outlets at 100-ft intervals around perimeter of building and beside each main entrance.

(ii) Cage housing

Provide outlets over each alley at 100-ft intervals.

(c) Special purpose outlets

(i) Where a mechanized system is to be installed provide circuits for:

feed conveying and automatic feeders,
pit or gutter cleaners,
egg gathering system.

(ii) Provide outlet for water heater (if electrical).

(iii) Ventilating fans (see Article 1.2.3.9.).

(2) Brooder houses

(a) Lighting outlets

(i) Broiler houses

Provide outlets 12 ft on centre controlled by wall switches and time clock. If a variable level of lighting is desired, provide rheostat control in addition to wall switches and time clock.

(ii) Started pullets

Provide outlets 12 ft on centre, controlled by wall switches and time clock. If a variable level of lighting is desired provide additional controls in addition to wall switches and time clock.

(iii) Provide one outlet for each 100 sq ft of feed room and service area.

(b) Convenience outlets

(i) Floor brooding

Provide outlets at 100-ft intervals around perimeter of building and beside main entrances and loading doors.

(ii) Cage brooding

Provide outlets over each alley at 100-ft intervals.

(c) Special purpose outlets

(i) Provide outlets for feed conveying and automatic feeding equipment.

(ii) For electric brooding provide capacity and outlets of approximately 3 watts per square foot of floor area.

(iii) Ventilating fans (see Article 1.2.3.9.).

(3) Egg-storage and handling rooms

(a) Lighting outlets

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

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

(b) Special purpose outlets

(i) Provide outlets for egg candler, egg washer, grader, conveyors, vacuum pumps, refrigeration and heating equipment.

(ii) Provide outlet for water heater(s) (if electrical).

2.2.4.13. Field Crop Structures

(1) Feed-grinding rooms

(a) Lighting outlets

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

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

(iii) Fixtures should be dustproof, the switch should also be dustproof unless mounted outside the room.

(b) Special purpose outlets

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

(2) Grain and feed storage

(a) Lighting outlets

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

(ii) Dustproof fixtures should be used, the switch should also be dust proof unless mounted outside the room.

(b) Convenience outlets

Outlets should be provided for grain aerators, augers and elevators as required.

(c) Special purpose outlets

Outlets should be provided where corn or grain driers or elevators are used.

(3) Mow areas

(a) Lighting outlets

(i) One outlet should be provided for every 1000 sq ft of floor area.

(ii) Fixtures should be dustproof.

(iii) Outlets should be located near the peak of roof so that hay chutes and ladders are well lighted.

(b) Convenience outlets

Provide an outlet beside each main doorway and each filling door for use with elevators.

(c) Special purpose outlets

Outlets should be provided as required for equipment such as hay dryers.

(4) Silos

(a) Lighting outlets

(i) 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 chute or at the entrance to the tunnel leading to the chute.

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

(b) Convenience outlets

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

(c) Special purpose outlets

A circuit should be provided for a silo unloader. A circuit for an ammeter should be included to regulate the load on the unloader. A safety device should be provided to permit locking out the ground level control switch for protection of the operator while he is in the silo.

(5) Tobacco stripping rooms

(a) Lighting outlets

Fluorescent outlets consisting of either a 4-lamp fixture (3 daylight, 1 deluxe warm white) or a 2-lamp fixture (1 daylight, 1 deluxe cool white) should be mounted 5 to 7 ft over front edge of stripping bench.

(6) Tobacco barns (Burley)

(a) Lighting outlets

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

2.2.4.14. Fruit and Vegetable Crop Structures

(1) Fruit and vegetable storage

(a) Lighting outlets

One outlet should be provided for every 300 sq ft of floor area, except in bulk potato storages, where one outlet with reflector for indirect lighting should be provided 16 ft on centre over alleyways.

(b) Convenience outlets

Outlets should be provided for use of supplementary lighting or portable equipment.

(c) Special purpose outlets

Circuits should be provided for refrigeration, ventilation, heating equipment if required, and other equipment.

(2) Sorting, grading, washing and packing rooms

(a) Lighting outlets

(i) Provide one outlet for every 100 sq ft of floor area.

(ii) Provide one outlet for each 5 lin. ft. of machine, such as washers, graders, conveyors, etc., with local wall switch control for each outlet or group of outlets.

(3) Greenhouses

(a) Lighting outlets

(i) One outlet should be provided for every 16 ft through the centre of the house.

(ii) One outlet should be provided over each work bench in the head house with a minimum of one outlet for every 5 ft of work bench.

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

(b) Special purpose outlets

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

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

2.2.4.15. Farm Workshops and Machinery Sheds

(1) Farm workshops

(a) Lighting outlets

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

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

(b) Convenience outlets

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

(ii) Provide weatherproof outlet on exterior of building near doorway.

(c) Special purpose outlets

(i) Provide outlets for local comfort heaters.

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

(iii) Local power supply authorities should be consulted concerning installation of electric welders.

(2) Machinery sheds

(a) Lighting outlets

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

(b) Convenience outlets

One outlet mounted 5 ft above floor for every 40 ft of perimeter for use with trouble lamp, portable drill, etc.

2.2.4.16. Water Supply

(1) Lighting outlet

One outlet should be provided over the pump.

2.2.4.16.

(2) Convenience outlets

One outlet should be provided near the pump for portable equipment such as drills, trouble lamp or heater.

(3) Special purpose outlets

(a) An outlet on a separate circuit should be provided for each pump motor.

(b) Outlets for the pump should be equipped with a disconnect 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, the pump motor 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.

(4) Grounding

(a) The pump motor should be properly grounded. See Article 1.2.3.11. (plastic pipe or other non-conductive material is not adequate for grounding).

(5) Water for fire protection (see Clause 2.2.5.1.(3)(d)).

2.2.4.17. Exterior Lighting

(1) Lighting outlets

(a) At least one yard light and lights over main doorways of livestock buildings should be provided.

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

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

(d) Security lighting to be provided as required.

2.2.4.18. Rabbit Structures

(1) Lighting outlets

(a) Provide outlets every 12 ft on centre line of feed passages.

(b) Provide one outlet for every 100 sq ft of floor area of feed preparation and utility areas.

(2) Convenience outlets

(a) Provide 1 outlet over each passageway at 100-ft intervals and beside main entrance.

SUBSECTION 2.2.5. WATER SUPPLY

2.2.5.1. Water Quantities

(1) Water consumption

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

TABLE XXVI

DAILY WATER REQUIREMENTS OF LIVESTOCK

Class of Livestock	Daily Water Requirements, gallons (US)
Milk cow	35
Beef or dry cow	15
Horse	15
Hog	2
Sheep	2
100 Laying hens	10
100 Turkeys	18

(b) Watering facilities in loose housing and other unheated structures should be protected against freezing by the use of CSA approved frostproof automatic electric water bowls, heated tanks, or frostproof hydrants.

(2) Water for cleaning purposes

(a) Cold water

Water should be available at a minimum rate of 200 gallons (US) per hr and a minimum pressure of 30 lb per square inch for washing floors of milking parlours, milk rooms, livestock pens and poultry houses.

(b) Hot water for dairy barns

(i) Hot water heaters should be equipped with a reliable thermometer installed in the delivery pipe and provide hot water at a temperature of 160°F.

(ii) Hot water heaters should have recovery rates capable of restoring the full hot water requirements during periods between milkings.

(iii) For pail milker systems in tie-stall barns, hot water heater capacities should be 20 gallons (imp.) for herds of 20 milking cows or less and 40 gallons (imp.) for herds of 21 to 75 milking cows. For herds greater than 75 milking cows, heater capacities should be based on 0.60 gallon (imp.) per milking cow and the next larger standard-size tank should be selected.

(iv) For portable dumping station and pipeline transfer systems in tie-stall barns, hot water heater capacities should be based on 0.25 gallon (imp.) per milking cow plus 0.33 gallon (imp.) per foot of pipeline*. The next larger standard-size tank should be selected.

(v) For pipeline milking systems in tie-stall barns, hot water heater capacities should be based on 0.20 gallon (imp.) per milking cow plus 0.12 gallon (imp.) per foot of pipeline*. The next larger standard-size tank should be selected.

(vi) For pipeline milking systems in milking parlours, hot water heater capacities should be based on 0.20 gallon (imp.) per milking cow plus 0.63 gallon (imp.) per foot of pipeline*. The next larger standard-size tank should be selected.

(c) Hot water for poultry buildings

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

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

*Turner, C.N., 1964 (see Bibliography).

(d) Hot water for other uses

Hot water and steam should be available in abattoirs and killing plants.

(3) Water for fire protection

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

(b) To allow the use of community fire fighting equipment, a water storage should be

(i) a minimum capacity of 5000 gallons (US),

(ii) readily accessible, and

(iii) no farther than 500 ft from the major farm structures.

(c) Farm pumps used for prevention of fire spread should have a minimum capacity of 5 gallons (US) per minute at 30 psi pressure.

(d) Electric motors on farm pumps used for fire protection should be supplied by an electrical circuit independent of all buildings.

2.2.5.2. Design of Water Distribution Systems

(1) General

(a) Water supply pipes and fittings should be of corrosion-resistant material.

(b) Permanent supply pipes should be laid below frost level. Where the distribution system is exposed to freezing temperatures, protection against freezing should be provided by the use of heating cable or other heating device.

(2) Pipe sizes

(a) General

Pipe size should be determined on the basis of pipe material, pipe length, flow requirement and minimum outlet pressure requirement.

(b) Pipe sizes for distribution systems with branching pipes should be determined according to the following:

(i) The pressure at any outlet should be at least 15 lb per square inch and depends on the "start" pressure of the pressure system, the elevation of the outlet, and the friction head loss (see Appendix D, Tables D-I to D-IV).

(ii) The distribution main pipe from the pressure system should be designed for a minimum flow rate of 10 gallons (US) per minute. When the pump capacity of the pressure system exceeds 10 gallons (US) per minute, the main pipe should be designed for a flow rate at least equal to the pump capacity.

(iii) Individual branch pipes to single outlets should be designed for the rated flow of the outlets. The branch pipe to a single hose bib should be designed for a flow rate of 5 gallons (US) per minute.

2.2.5.3. Installation of Water Supply and Distribution Systems

(1) The water supply and distribution system should be installed in accordance with Part 7, Plumbing Services, of the National Building Code of Canada, 1970.

(2) All materials used in water supply systems should be of good quality and should comply with the specifications in Part 7, Plumbing Services, of the National Building Code of Canada, 1970.

(3) Pumps and other devices should be installed in such a manner to provide protection against contamination and to ensure efficient operation and maintenance.

2.2.5.3.

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

(5) Shallow well pumps should not be installed more than 22 ft above the anticipated water level at time of maximum draw down.

SUBSECTION 2.2.6. WASTE DISPOSAL

2.2.6.1. Manure Storage

(1) The design capacity of manure storage facilities should be based on the quantities shown in Table XXVII.

TABLE XXVII
MANURE STORAGE VOLUMES

Class of Livestock	Manure Production, cu ft/animal-day	Required Storage For Liquid Manure, cu ft/animal-day	Required Storage For Solid Manure Including Bedding, cu ft/animal-day
Cattle			
Beef or dairy calves (0 to 3 mo.)	0.06	0.085	
Beef or dairy calves (3 to 6 mo.)	0.25	0.35	
Beef feeders or dairy heifers (6 to 15 mo.)	0.50	0.70	0.6
Beef feeders or dairy heifers (15 to 24 mo.)	.75	1.1	0.8
Beef cows (1200 lb)	1.0	1.4	1.2
Dairy cows (1200 lb)	1.6*	2.2	
-Open pen loose housing			2.0
-Free stall loose housing		2.4	1.7
-Tie stall			1.8
Swine			
40-200 lb (8 to 22 wks.)	0.18*	0.25	0.25
10-25 lb (3 to 6 wks.)	0.04	0.055	
25-50 lb (6 to 9 wks.)	0.08	0.11	
51-75 lb (9 to 12 wks.)	0.12	0.17	
76-125 lb (12 to 16 wks.)	0.18	0.25	
126-175 lb (16 to 20 wks.)	0.26	0.36	
176-200 lb (20 to 22 wks.)	0.32	0.45	
Sows	0.40*	0.56	0.48
Chickens			
Broilers (0 to 4 lb)	0.0028		0.005
Laying hens (5 lb)	0.005		
Turkeys			
Broilers (0 to 14 wks.)	0.0045		
Growing hens (0 to 22 wks.)	0.0065		

TABLE XXVII (Cont'd)

Class of Livestock	Manure Production, cu ft/animal-day	Required Storage For Liquid Manure, cu ft/animal-day	Required Storage For Solid Manure Including Bedding, cu ft/animal-day
Growing toms (0 to 24 wks.)	0.01		
Breeding flocks	0.012		
Rabbits (doe and litter)	0.025		
Sheep	0.010*	0.24	0.15
Horses	0.92*		2.0

Note to Table XXVII:

* Berglund, S., G. Aniansson, and I. Ekesbo., 1965 (see Bibliography).

(2) Sufficient storage capacity should be provided to avoid the necessity of disposal on snow, frozen ground or sensitive crops. Fall and spring land applications are most desirable to obtain maximum utilization of plant nutrients in the manure.

2.2.6.2. Dead Bird Disposal

(1) Disposal pit capacities should be based on flock size as follows:

(a) 20 cu ft per 1000 broilers.

(b) 100 cu ft per 1000 layers.

2.2.6.3. Disposal of Milk Wastes

(1) Capacities of sediment tanks for wash water containing milk wastes should be as given in Table XXVIII(a).

TABLE XXVIII(a)

SEDIMENT TANK CAPACITIES FOR MILK WASTES

No. of Cows	Volume, Gallons (imp.)	Settling Compartment		
		Length	Width	Water Depth
Up to 25	500	6 ft 9 in.	3 ft 0 in.	4 ft 0 in.
26 to 45	600	8 ft 0 in.	3 ft 0 in.	4 ft 0 in.
46 to 65	720	9 ft 0 in.	3 ft 3 in.	4 ft 0 in.
66 to 100	900	9 ft 0 in.	3 ft 6 in.	4 ft 6 in.

(2) Sediment tanks should be constructed to permit ready removal of sediment. Cleaning will be required at regular intervals depending upon sanitation and other practices.

(3) Material removed from sediment tanks should be disposed of in a manner acceptable to local authorities.

(4) Size of underground disposal field for effluent from sediment tanks should be as given in Table XXVIII(b).

(5) Approval and suitable plans for sediment tank and disposal field design should be obtained from local authorities.

2.2.6.3.

TABLE XXVIII(b)

SIZE OF UNDERGROUND DISPOSAL FIELD FOR MILK WASTES

No. of Cows	Length of Tile Trench, ft.		
	Subsoil Drainage		
	Good (Sand and gravel)	Medium (Sandy loam soil)	Poor (Silt and clay loam soil)
Up to 25	100	100	150
26 to 45	100	180	270
46 to 65	130	260	390
66 to 100	200	400	600

2.2.6.4. Manure Lagoon (see Article 1.3.2.5.)

Note: Under many conditions the use of lagoons alone is not a practical method of disposing of livestock manures.

2.2.6.4.(1) Loading rates

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

(i) Climatic data including precipitation-evaporation ratio.

(ii) Proximity to populated areas and water supplies.

(iii) Effect of effluent on streams.

(iv) Local regulations.

(b) Aerobic lagoons

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

(i) Aerobic lagoons may be constructed only in those cases where:

no other method of manure disposal is available;

stringent health regulations prohibit the use of anaerobic or combined anaerobic-aerobic lagoons;

an adequate supply of water is available to dilute the manure.

(ii) Where aerobic lagoons are required, approval of designs should be secured from proper local health and/or water authorities before construction is begun. Table XXIX should be used to convert loading rates for domestic sewage to agricultural use.

TABLE XXIX

LOADING RATES FOR AEROBIC LAGOONS*

Waste Source	Population Equivalent	Animals per Acre of Lagoon		
Man	1	Domestic Sewage Loading Rates (Population/acre)**		
		100	150	200
Cows	16.4	6	9	12
Horses	11.3	9	13	18
Sheep	2.45	40	60	80
Hogs	1.9	52	80	105
Chickens	0.014	7,000	10,500	14,000

Notes to Table XXIX:

* Eby, Harry J., 1963 (see Bibliography).

** Consult proper local Health and/or Water Authorities for allowable domestic sewage loading rates.

(c) Anaerobic lagoons

"Anaerobic lagoon" means a lagoon in which the treatment of waste material is achieved in the absence of oxygen. This lagoon is essentially an open cesspool.

(i) Anaerobic lagoons should be used only where adequate space separation from dwellings and neighbouring properties and prevailing wind direction is such that odours will not create a nuisance.

(ii) The effluent from overflowing anaerobic lagoons should receive further treatment by spreading on crop land or by discharging into aerobic lagoons. The effluent may not be of acceptable quality by local health and/or water authorities for discharge into a receiving body of water.

(iii) Where anaerobic lagoons are used, approval of designs should be secured from proper local health and/or water authorities before construction is begun. Table XXX may be used to determine the volume of lagoon required.

TABLE XXX

LOADING RATES FOR ANAEROBIC LAGOONS

Waste Source	Volume of Lagoon, cu ft/animal
Cows	2100
Horses	1800
Sheep	300
Hogs	240
Chickens	6

Note to Table XXX:

The figures in Table XXX have been arrived at by observing lagoons that appear to operate in a satisfactory manner.

(d) Combined anaerobic-aerobic lagoons

"Combined anaerobic-aerobic lagoon" means a lagoon system with 2 (or more) cells operated in series where fresh manure is deposited in the first cell for anaerobic treatment and the effluent flows into the subsequent cell(s) for aerobic treatment.

(i) These lagoons should be used only where their odours will not create a nuisance. (See Subclause 2.2.6.4.(1)(c)(i).)

(ii) Where anaerobic lagoons may not be permitted (see Subclause 2.2.6.4.(1)(c)(ii)), combined anaerobic-aerobic lagoons may produce a final effluent acceptable for discharge into a receiving body of water.

(iii) Where combined anaerobic-aerobic lagoons are used, approval of designs should be secured from proper local health and/or water authorities before construction is begun. Tables XXXI(a) and (b) may be used to determine the capacities of the anaerobic and the aerobic cells required.

TABLE XXXI(a)
LOADING RATES FOR ANAEROBIC CELL OF COMBINED ANAEROBIC-AEROBIC LAGOONS DESIGNED FOR A MANURE RETENTION PERIOD OF ONE YEAR

Waste Source	Volume of Anaerobic Cell to Provide Manure Retention for one Year, cu ft/animal
Dairy cows	585
Beef cows	365
Horses	335
Sheep	36
Hogs (no bedding)	65
Sows and litter	260
Layers	1.5

TABLE XXXI(b)
LOADING RATES FOR AEROBIC CELL OF COMBINED ANAEROBIC-AEROBIC LAGOONS

Waste Source	Animals Per Acre of Aerobic Cell		
	Domestic Sewage Loading Rates, Population/acre*		
Man	100	150	200
Cows	43	65	86
Horses	50	75	100
Sheep	275	413	550
Hogs	360	540	720
Chickens	15,000	22,000	30,000

Notes to Table XXXI(b):

* Consult proper local health and/or water authorities for allowable domestic sewage loading rates.

Consult proper local authorities before allowing effluent to discharge to receiving waters. Further treatment can be provided by additional aerobic cells if required.

2.2.6.4.

(2) Shape

(a) Lagoons should be regular in shape with rounded corners and a flat bottom.

(b) Embankments should have a minimum top width of 8 ft and side slope of 1 vertical to 3 horizontal.

(3) Depth

(a) The operating depth of liquid in aerobic lagoons, or aerobic cells of combined anaerobic-aerobic lagoons, should be capable of being varied from 2.5 ft to 5 ft in order to allow the liquid level to be raised to 5 ft during winter months. The operating depth during ice-free periods should not be greater than 3.5 ft.

(b) The operating depth of liquid in anaerobic lagoons, or anaerobic cells of combined anaerobic-aerobic lagoons, should be at least 6 ft.

(c) The top of the embankment should be at an elevation at least 2 ft above maximum operating liquid elevation.

(4) Inlets

(a) The waste inlet should slope at least 1 vertical to 50 horizontal, be at least 6 in. in diameter and discharge at any elevation of at least 2 ft above the maximum operating liquid level in the lagoon.

(b) In areas where snow and ice would block an elevated inlet, wastes should be pumped through the inlet and discharged below ice level near the centre of the lagoon.

(5) Outlets

(a) The outlet structure should be placed so that ice will not damage the structure. The outlet should be constructed so that the liquid depth can be changed and the lagoon drained when necessary.

(6) Miscellaneous

(a) Lagoons should be filled with water to a depth of 2 ft before they are put into operation.

2.2.6.5. Crop Land Requirements for Manure Disposal

(1) The total acreage required for the disposal of livestock manures by spreading on cropland is determined by the volume of manure produced and the utilization of nitrogen, phosphorous and potash by the crop. The nitrogen factor is of most importance as excessive build-up of nitrates must be avoided.

(2) Table XXXII provides design information based on efficient crop utilization of nitrogen and the minimum acreage needed where pollution control is the chief criterion of design.

TABLE XXXII

LAND REQUIREMENTS FOR MANURE DISPOSAL*

Class of Livestock	Crop Land for Manure Utilization,** acres/animal	
	Crop Utilization***	Pollution Control****
Beef feeder cattle	0.5	0.25
Dairy cattle	1.0	0.5
Market hogs	0.2	0.1
Chicken broilers	0.004	0.002
Laying hens	0.01	0.005

Notes to Table XXXII:

* Jones, G.E., T.H. Lane and L.R. Webber, 1968 (see Bibliography).

** Crops such as continuous corn, forage or potatoes.

*** Minimum land areas in continuous crops for the efficient use of nitrogen in the manure.

**** Minimum land areas in continuous crops where the nitrogen will neither reduce crop yields nor cause water pollution. For pollution control on sandy soils, which are more subject to nitrate leaching, use acreage values under the "Crop Utilization" column.

SECTION 2.3. CONSTRUCTION PRACTICES

SUBSECTION 2.3.1. GENERAL

2.3.1.1.(1) All materials, systems and equipment shall possess the essential properties to perform their intended functions in the structures.

(2) All members shall be so framed, anchored, fastened, tied and braced together to provide the strength and rigidity necessary for the purpose intended.

SUBSECTION 2.3.2. CLADDING

This Subsection deals with the design, properties and application of cladding for farm buildings.

2.3.2.1. Aluminum

(1) General

(a) Cladding should be applied to effect a weather-tight seal and to present a neat and workmanlike appearance.

(b) Sheets should be stored in a dry place or in such a manner as to allow air circulation between the sheets to avoid condensation. Wet sheets should be separated immediately and allowed to dry to prevent staining.

(c) Holes for fixing should be 1 in. or more from the ends of the sheets.

(d) All exposed edges of the side laps should finish down and this edge should turn away from the prevailing winds. Fasteners for siding should be located in the valley of the profile and adjacent to the rib.

(e) Purlin and girt spacings depend upon local climatic conditions and the strength of the sheet. These should be in accordance with the manufacturer's recommendations except that purlin spacing at eaves and ridge should be 50 per cent of recommended spacing of intermediate purlins.

(f) Loading tables for exterior cladding are dependant on the span and sheet profile. (See Appendix M, Tables M-I to M-III, and Figures 1-M to 3-M.)

(g) Typical accessories for metal roofing and sidings (see Appendix M, Figure 4-M).

(h) Copper or bare steel accessories should not be used either in contact with aluminum or where water could drip from them onto the aluminum.

(i) When aluminum sheets are to be applied over hardwood, a 15-lb asphalt-impregnated felt should first be placed over such wood. An alternative is to apply two coats of bituminous paint.

(j) Where aluminum sheets are to be applied in contact with concrete, two coats of bituminous paint should be applied or a 15-lb asphalt-impregnated felt placed over the concrete.

(k) Fasteners should be of aluminum or galvanized steel.

(2) Roofing

(a) The roof slope should be a minimum of 4 in 12 when shallow profiles, such as Figure 1-M, Appendix M, are used and a minimum of 3 in 12 when deep profiles such as Figures 2-M and 3-M are used.

(b) Sidelaps should be as per manufacturer's recommendations but should be nailed at each purlin and consist of 1 rib or more with both sides of the rib supported by purlins.

(c) Endlaps should be as per manufacturer's recommendations but should be 6 in. or more and supported by a purlin.

(d) Fasteners should be noncorrosive to aluminum and have a spiral or ring shank when applied in wood purlins. For metal purlins use self tapping screws or bolts and nuts. Fasteners should be provided with washers which seal the hole when the fastener is tightened. Fasteners should be through the crown of the rib at each purlin and spaced across the sheet as per manufacturer's recommendations. In marine atmosphere use aluminum nails with neoprene washers.

(e) Reroofing

Aluminum roofing can be applied over old roofing provided the roof deck is solid and the old roofing is clean, dry and flat and loose pieces are fastened down. It is good practice to restrap over old roofing with 1-in. by 4-in. strapping fastened in a secure manner. Aluminum roofing should not be applied directly over old metal, slate or tile. Where new aluminum roofing laps other metals apply a coat of bituminous paint between the sheets before lapping.

(3) Siding

(a) Sidelaps should be as per manufacturer's recommendations, but should be nailed at each purlin and consist of 1 rib or more.

(b) Endlaps should be as per manufacturer's recommendations but 4 in. or more and supported by a girt.

(c) Fasteners should be noncorrosive to aluminum and have a spiral ring shank.

(4) Prepainted aluminum

The coating should be designed to meet the properties in Appendix M, Table M-VII.

2.3.2.2. Asbestos Cement, Corrugated

(1) General

(a) Cladding should be applied to afford a weathertight seal and to present a neat and workmanlike appearance.

(b) Sheets should be stored in a dry place.

(c) No hole for fixing shall be nearer than 1 in. to the end of a sheet.

(d) All sidelaps should be installed away from prevailing winds.

(e) Purlin and girt spacings depend upon local climatic conditions. These should be in accordance with the manufacturer's recommendations.

(2) Roofing

(a) Recommended minimum roof slope should be 3 in 12.

(b) Sidelaps should be 1 corrugation with caulking between corrugations.

(c) Endlaps should be a minimum of 6 in., supported by a purlin, with caulking between sheets.

(d) Corrosion-resistant fasteners should have a spiral or screw shank and be provided with washers which will seal the hole when the fastener is tightened. Fasteners should be through the crown of the corrugation at each purlin and spaced across the sheet as per manufacturer's recommendations.

(e) Corrugated asbestos-cement roofing can be applied over old wood roofing provided the deck is solid and old material is clean, dry and flat and loose pieces are fastened down. It is good practice to restrap over old roofing with 1-in. by 4-in. strapping fastened in a secure manner. Asbestos-cement roofing should not be applied over old metal, slate, or tile roofing.

(3) Siding

(a) Sidelaps should be 1 corrugation with caulking between corrugations.

(b) Endlaps should be a minimum of 6 in. and supported by a girt.

(c) Corrosion-resistant fasteners should have a spiral or screw shank and be provided with weather sealing washers.

2.3.2.3. Asphalt, Insulating

(1) General

(a) Insulating asphalt siding should be applied in such a way as to form a weathertight seal and to present a neat, and workmanlike appearance.

(b) Insulating asphalt siding should be stored in a dry storage and protected from moisture prior to and during application.

(c) Insulating asphalt siding should not be applied direct to wood studding if the interior of the building is to be lined.

(d) In application of insulating asphalt siding to a building which is to be lined, it is recommended the studs be furred and strapped or that a nailable subsheathing be applied over the studding and strapped in accordance with the manufacturer's recommendations. This is necessary in order to allow for the required breather space behind the siding panels.

(2) Preparation

(a) If insulating asphalt siding is to be applied direct to wood studding, the studs should be spaced a maximum of 16 in. o.c. and back blocking provided to support each top and bottom panel edge.

(b) Prior to application, new or old wood boards, plywood, shingles or wood siding should be tightly nailed or renailed and any rotted wood replaced in order to form a true smooth surface.

(c) Prior to application, the stucco and lath should be removed from old stucco surfaces.

(d) A breather-type sheathing paper should be applied over all types of subsheathing prior to strapping.

(e) All surfaces should be dry prior to commencement of application.

(3) Application

(a) Vertical wood strapping to form an air space should be applied to all types of subsheathing in accordance with the manufacturer's recommendations.

(b) A minimum of 3/8-in. breather space should be provided between the siding panels and the subsheathing.

(c) The siding application procedure as provided by the manufacturer should be closely followed.

(d) The specified nails and nailing procedure for application of the siding should be in accordance with the manufacturer's recommendations.

(e) Corner finishing to complete the installation should be installed in accordance with the manufacturer's recommendations.

(f) The panel edges at all doors and windows should be caulked at the conclusion of the siding application in order to insure a weathertight seal.

2.3.2.4. Lumber Siding

(1) Lumber siding should be free of knot holes or loose knots larger than ½ in. diameter and no checks or splits longer than one-half of the width of the piece.

(2) Bevel siding should be not less than 3/16 in. thick at the tip and 7/16 in. at the butt. Bevel siding should be not more than 12 in. wide. Other siding, including vertical wood siding, should be not less than 9/16 in. thick and not more than 12 in. wide.

(3) Furring should be at least 1 in. by 2 in. lumber if the furring is applied horizontally over sheathing. When furring is applied without sheathing, to studs not more than 48 in. on centres, it should be not less than 2 in. by 2 in. or 1 in. by 4 in. wood.

(4) Lumber siding should prevent water from entering at the joints by the use of lapped or matched joints or by vertical wood battens. Siding should overlap at least 1/16 in. per inch width of lumber but not less than 3/8 in. for matched siding, 1 in. for lapped bevel siding or ½ in. for vertical battens. Joints should be butted over studs, furring, blocking or lumber sheathing.

(5) Lumber siding should be fastened with corrosion-resistant nails spaced not more than 24 in. on centres, to framing, furring or lumber sheathing or to blocking nailed between framing members and spaced not more than 24 in. on centres.

(6) Blocking should be not less than 2-in. by 2-in. lumber.

(7) Wood roof shingles.

(a) Shingles should be No. 2 grade or better.

(b) Decking for wood shingled roofs may be continuous or spaced.

(c) Wood shingles should be at least 16 in. long and not less than 3 in. or more than 14 in. wide.

(d) Shingles should be spaced approximately ¼ in. apart and offset at the joints in adjacent courses at least 1½ in. in such a manner that joints in alternate courses do not line up.

(e) Shingles should be fastened with 2 corrosion-resistant 14-gauge shingle nails or equivalent located approximately ¾ in. from the sides of the shingles and 1½ in. above the exposure line.

2.3.2.4.(7)

(f) The maximum exposure of wood roof shingles should conform to Table XXXIII.

TABLE XXXIII

MAXIMUM EXPOSURE OF WOOD ROOF SHINGLES

Roof Slope	Maximum Shingle Exposure, in.		
	16-in. shingles	18-in. shingles	24-in. shingles
4/12 or less	3¾	4¼	5¾
Over 4/12	5	5½	7½

2.3.2.5. Particleboard, Type I (Exterior)

(1) General

Particleboard used in farm structures should be phenolic bonded conforming with CSA Specification O188-1968, Building Board Type I grade P.

It should be marked with a stamp or brand on the panel edge that includes the symbol P 100.

(2) Standard grades of exterior particleboard are unsanded, and sanded one side; sizes are 4 ft by 8 ft and 4 ft by 16 ft and thicknesses are ¼ in., 5/16 in., ⅜ in., ½ in., ⅝ in. and ¾ in.

(3) Floors

Floor loads up to 40 lb per square foot may be supported by 5/8-in. particleboard over joists 16 in. o.c. or ¾ in. over joists 20 in. o.c. Install 2 x 2 minimum blocking between joists to support particleboard edges.

(4) Walls

Recommended applications of exterior particleboard wall sheathing, cladding and interior finish for farm structures are given in Table M-VIII, Appendix M.

(5) Finishes

For exterior application unsanded exterior particleboard is recommended. Use a light or medium bodied stain or, for a solid colour finish, use a heavy bodied shingle stain.

(6) Roofs

Recommended applications of exterior particleboard for flat, flat-pitched, or pitched roofs on farm buildings are covered by Table M-IX, Appendix M. These recommendations are suitable for areas in which the National Building Code specifies a ground snow load of 60 lb per square foot or less.

2.3.2.6. Plywood

(1) General

(a) Plywood used in farm structures should be exterior type conforming with one of the following standards:

CSA O121-61 Douglas Fir Plywood.

CSA O151-61 Western Softwood Plywood.

CSA O153-63 Poplar Plywood.

It should be marked "EXTERIOR" or "WATERPROOF GLUE" with a stamp or brand which includes identification of the Plywood Manufacturers Association.

(2) Standard grades, sizes and recommended applications of fir plywood are given in Table M-IV, Appendix M.

(3) Walls

(a) Recommended applications of fir plywood wall sheathing, cladding and interior finish for farm structures are given in Table M-V, Appendix M.

(4) Finishes

(a) A stain finish is recommended for Sheathing or Select Sheathing grade plywood panels exposed to the weather. A heavy bodies stain of the type sold as shingle or shake stain is recommended and will provide an attractive finish requiring little maintenance.

(b) For a high quality paint finish the use of Medium Density Overlaid fir plywood is recommended. Painting recommendations for Medium Density Overlaid plywood are as follows:

(i) Surface preparation

Medium Density Overlaid plywood needs no surface preparation. No presanding or sealer coats are required. However, it is important that the surface has been dry for at least 48 hours and is completely clean before application of paint.

(ii) Prime coat

Any good primer, properly formulated and designed for exterior exposure, may be used with satisfactory results. The limitations are as follows:

1. Strict adherence to the paint manufacturer's recommendations.
2. Compatibility of the prime coat to the top coat must be considered. The use of flexible film forming primers, such as some of the latex or oleoresinous based formulations, should be avoided when they are to be top coated with a hard film forming paint.

(iii) Top or finish coat

Nearly all good quality paints formulated for exterior finish are acceptable. As with the prime coat, the manufacturer's recommendations must be followed, and the compatibility of the top coat to the primer should be considered.

(5) Roofs

Recommended application of fir plywood roof sheathing for flat, flatpitched, or pitched roofs on farm buildings are covered by Table M-VI, Appendix M. These recommendations are suitable for areas in which the National Building Code specifies a ground snow load of 60 lb per square foot or less. To support point loads imposed during construction these thicknesses should not be reduced nor should these spans be increased. Plywood roof sheathing should be applied with face grain at right angles to rafters or other primary supports.

For ground snow loads higher or substantially lower than 60 lb per square foot reference should be made to load span figures, Figures 5-M to 9-M, Appendix M.

(6) Load/span graphs

For plywood applications subject to continuous uniformly distributed loading, load/span figures, Figures 5-M to 9-M in Appendix M may be used as a guide to determine suitable thicknesses of plywood and spacing of supports.

2.3.2.7. **Steel**

(1) General

(a) Cladding should be applied to afford a weathertight seal and to present a neat and workmanlike appearance.

(b) Sheets should be stored in a dry place or in such a manner as to allow air circulation between the sheets to avoid condensation. Wet sheets shall be separated immediately and allowed to dry to prevent staining.

(c) No hole for fixing should be nearer than 1 in. to the end of a sheet.

(d) All side laps should be installed away from prevailing winds.

(e) Purlin and girt spacings depend upon local climatic conditions and the strength of the sheet. These shall be in accordance with the manufacturer's recommendations. Purlin spacing at eave and ridge shall be 50 per cent of recommended spacing of other purlins.

(f) Loading tables for exterior cladding are dependent on the span and sheet profile (see Appendix M. Tables M-I, to M-III, and Figures 1-M to 3-M.)

(g) Typical Accessories for metal roofing and siding (see Appendix M, Figure 4-M).

(2) Roofing

(a) The roof slope should be a minimum of 4 in 12 when shallow profiles such as Figure 1-M, Appendix M, are used and a minimum of 3 in 12 when deep profiles such as Figures 2-M and 3-M are used.

(b) Sidelaps should be as per manufacturer's recommendations, but should consist of a minimum of 1 rib with both legs of the rib supported.

(c) Endlaps should be as per manufacturer's recommendations, but should consist of a minimum of 1 rib with both legs of the rib supported.

(d) Fasteners should be corrosion resistant and should have a spiral or screw shank and be provided with washers which will seal the hole when the fastener is tightened. Fasteners should be through the crown of the rib at each purlin and should be spaced across the sheet as per manufacturer's recommendations. Fasteners for siding should be located in the valley of the profile and adjacent to the rib.

(e) Reroofing

Galvanized steel roofing can be applied over old roofing provided the deck is solid and the old material is clean, dry and flat and loose pieces are fastened down. It is good practice to restrap over old roofing with 1-in. by 4-in. strapping fastened in a secure manner. Galvanized steel roofing shall not be applied directly over old metal, slate or tile.

(3) Siding

(a) Sidelaps should be as per manufacturer's recommendations.

(b) Endlaps should be as per manufacturer's recommendations, but should be a minimum of 4 in. and supported by a girt.

(c) Fasteners shall have a spiral or screw shank and be corrosion resistant.

(4) Finishes

(a) Zinc coating

The steel core of ASTM A446 grade A is protected with a minimum of 1.25 oz. per square foot continuous hot dipped galvanized coating complying with the requirements of ASTM A525-67, General Requirements for Delivery of Zinc-Coated (Galvanized) Iron or Steel Sheets, Coils and Cut Lengths Coated by the Hot-Dip Method.

(b) Prepainted zinc coated steel

2.3.2.7.(4)(b)

The core and zinc coated steel as in Clause 2.3.2.6. (4) (a) are protected with proven colours on the exterior building side. The interior side must have at least one wash coat. For paint qualification test see Table M-VIII Appendix M.

SUBSECTION 2.3.3. VAPOUR BARRIERS

2.3.3.1. Materials

Materials should conform to requirements for Type I Vapour Barrier in accordance with CGSB Specification 70-GP-1, 1960 amended June 1962, Vapour Barriers; Sheet, for use in Above-Grade Building Construction, published by the Canadian Government Specifications Board, or otherwise provide permanent resistance to the passage of water vapour of 0.25 perms or less when applied.

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

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

SUBSECTION 2.3.4. INSULATION

2.3.4.1. 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 and ventilation air (see Tables on heat production in Appendixes I and J) and to prevent condensation.

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

2.3.4.2. Insulation Values

For insulation values (R) of selected materials frequently used in farm building construction, see Tables N-I, and N-II Appendix N. For a more complete listing of insulation values refer to the ASHRAE Guide and Data Book published by the American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc.

2.3.4.3. Materials

(1) Insulating materials should conform to the following specifications: Cork; Thermal, Insulation Board, Fed. Spec. HH-I-525 A, 4 October 1968; and Cork; Granulated, Insulating, Fed. Spec. HH-C-571 B, 23 June 1964, published by the U.S. General Services Administration; Fibreboard; Insulating, CGSB 11-GP-2, 1960, (amended May 1962), published by the Canadian Government Specifications Board. Mineral Wool Thermal Building Insulation; CSA A101 1968, published by the Canadian Standards Association; Polystyrene; cellular, 41-GP-14, 19 May 1961, (amended 23 February 1962) published by the Canadian

Government Specifications Board. Vermiculite; ASTM C516-57, Specifications for Vermiculite Loose Fill Insulation.

(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.

(4) Damaged insulation should be repaired or replaced.

(5) Polystyrene based foam insulations are readily soluble in many organic solvents including petroleum oils and fuels; polystyrene foam should therefore be used only where there is no contact with such chemicals.

2.3.4.4. 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) In new buildings loose fill insulation should be used only on horizontal surfaces 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 12 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.

2.3.4.5. Insulation and Surface Protection for Unit Masonry

(1) When granular insulation is used in conjunction with masonry units, the warm side of the walls should be sealed with a vapour 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 to mechanical damage it should be covered with a protective plaster coat or other suitable material.

SUBSECTION 2.3.5. WOOD PRESERVATION

2.3.5.1.(1) Wood in contact with earth, manure packs, or deep poultry litter should be pressure treated with an effective preservative in accordance with CSA Specification O80-1966, Wood Preservation. Cedar poles for pole barns may be used without treatment, but the life expectancy will be appreciably less than that of pressure treated poles. With other species, thermal (hot and cold bath) treatment with an oil type preservative will provide greatly increased life. Soaking of well-seasoned material for at least 48 hours in an oil type preservative will provide increased life somewhat less than that provided by thermal treatment.

(2) Fruit, vegetables, or grain should not be placed in contact with toxic preserved wood.

2.3.5.1.

(3) Wood that has been pressure-treated in accordance with the requirements of CSA Specification O80-1966, Wood Preservation, 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, 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 O80-1966, Wood Preservation, published by the Canadian Standards Association.

SUBSECTION 2.3.6. DRAINAGE

2.3.6.1. General

(1) In wet areas, exterior foundation walls should be drained by laying drain tile or perforated drain pipe around the exterior of the foundation so that the top of the tile or pipe is below the bottom of the floor slab.

(2) Drainage tile or pipe should be laid on a uniform grade to carry the water away from foundations to an outlet that always remains open.

(3) Drain tile with butt ends should be laid with ¼ in. to ⅜ in. open joints and cover strips at least 3 in. wide should be placed over at least the top half of the open joints.

(4) When perforated drain pipe is used, the pipe should be laid with perforations down. Such pipe may be connected with couplings.

(5) At least 6 in. of granular material should be placed over the tile or pipe.

2.3.6.2. Slabs Below Grade

(1) Where groundwater levels may cause uplift pressures against the bottom of a slab-below-grade, lateral drains should be installed under the slab.

2.3.6.3. Slabs-on-Grade

(1) The accumulation of water underneath a slab-on-grade should be prevented by grading, drainage or other method.

2.3.6.4. Floor Slopes

(1) For drainage, livestock floors should slope at least ⅛ in. per foot except as follows:

(a) Hog floors, dunging area, at least ½ in. per foot.

(b) Hog floors, bedded area, ¼ in. per foot.

(c) Yard slabs, ¼ in. per foot.

(d) Dairy barn stalls and litter alleys, ¼ in. per foot.

(e) Milking parlours, cow platform area, ½ in. per foot.

(f) Gutters for mechanical gutter cleaners, zero slope except at point where gutter passes through exterior wall, slope inwards 1 in. per 4 ft to prevent freezing.

LIST OF AGENCIES ISSUING STANDARDS AND GRADING RULES

Standards referred to in this document can be obtained direct from:

American Concrete Institute,
Box 4754 Redford Station,
22400 West Seven Mile Road,
Detroit, Michigan. 48219, U.S.A.

American Society for Testing and Materials,
1916 Race Street,
Philadelphia, Pennsylvania. 19103, U.S.A.

British Standards Institution,
101 - 112 Pentonville Road,
London N. 1, Great Britain.

Canadian Government Specifications Board,
88 Metcalfe Street,
c/o Department of Supply and Services,
Ottawa 4, Canada.

Canadian Standards Association,
178 Rexdale Boulevard,
Rexdale, Ontario

Incinerator Institute of America,
630 Third Avenue,
New York 17, New York, 10017, U.S.A.

United States General Services Administration,
c/o Superintendent of Documents,
U.S. Government Printing Office,
Washington D.C. 20402, U.S.A.

Grading rules referred to in this document can be obtained direct from:

British Columbia Lumber Manufacturers Association (BCLMA and WCLIB).
1477 West Pender Street,
Vancouver 5, British Columbia.

Canadian Lumbermen's Association (CLA, ESGC and NELMA)
27 Goulbourn Avenue,
Ottawa 2, Ontario

Quebec Lumber Manufacturers Association (EPGC)
P.O. Box 657,
5 du Parloir Street,
Quebec 4, P.Q.

Western Wood Products Association (WWPA)
700 Yeon Building,
Portland, Oregon 97204, U.S.A.

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Preliminary Broiler Heat and Moisture Data for Designing Poultry Houses and Ventilation Systems. Amer Soc Agr Engrs, Paper No. 65-411, June 1965.

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APPENDIX A

LOADS IMPOSED BY STORED GRAIN, POTATOES AND SILAGE

LOADS IMPOSED BY STORED GRAIN

DEFINITIONS

(1) Shallow Bin

Depth of grain (H) less than or equal to equivalent diameter (D).

Or: $\frac{H}{B} < \tan\left(\frac{\phi}{2} + 45°\right)$

where B = width

ϕ = angle of repose (see Table A-II).

(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) (see Table A-II).

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.

A. SHALLOW BINS

From Rankine's development:

(1) Lateral Load on Vertical Walls

$l = EFD \times H$

where l = lateral load, lb/sq ft

EFD = Equivalent Fluid Density (see Table A-II)

H = depth of grain, ft.

(2) Total Lateral Load

$L = EFD \times \frac{H^2}{2}$

where L = the total lateral load on a vertical wall section, 1 ft wide

EFD = Equivalent Fluid Density (see Table A-II).

H = depth of grain, ft.

(3) Vertical Loads on Vertical Walls

$V = u' \times L$

u' = coefficient of friction for grain on wall (see Table A-I).

(4) Vertical Loads on Horizontal Floors

$V = E\ F\ D \times H$

Conservative V = Bulk Density x H (see Table F-II for bulk density).

(5) **Design Values – Equivalent Fluid Density (EFD)**

Effect of storage time: increase figures in Table A-II 25 per cent for storage longer than one year.
Effect of surcharge: increase figures in Table A-II 25 per cent 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.)

(6) **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.)

(7) **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**

$$L = \frac{wD}{4u'}\left(1 - e^{(-4Ku'\ H)/D}\right)$$

where: L = lateral pressure, psf
w = material density, pcf
D = bin diameter, or equivalent diameter, ft
K = ratio of lateral to vertical internal pressure
$= (1 - \sin \phi) / (1 + \sin \phi)$
ϕ = angle of repose (see Table A-II)
u' = coefficient of friction, material on wall
H = depth of grain, ft
e = Napierian log base

(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.

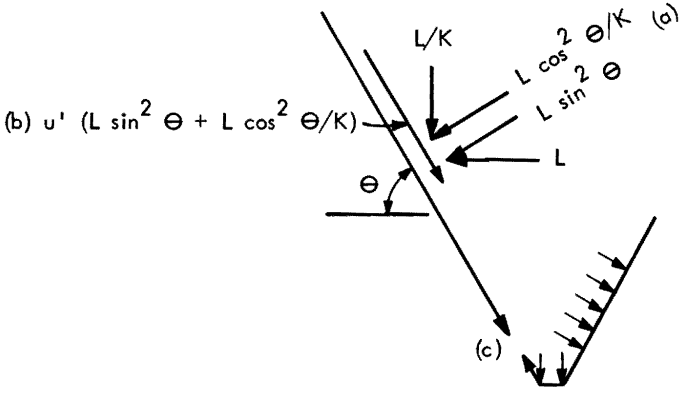
(2) Deep bins – at any given depth, the forces on the hopper surface are:

(a) Normal pressure $= L\sin^2\theta + L\cos^2\theta / K$ where θ 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 times 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.

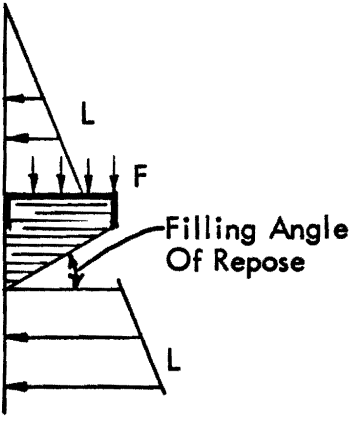


D. VERTICAL LOADS ON WALLS WITH EXPOSED HORIZONTAL GIRTS

Wall Load = F + V

F = vertical load on girts.

V = u' X 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 per cent 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 per cent. Pressures will increase 10 times with a 10 per cent 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 A-I.

TABLE A-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.	Poly-ethy-lene	Mild Steel C.R.	Gal-vanized Sheet Metal
Oats	10.6	.28	.40	.43	.20	.23	.27	.29	.20	.20	.22
	13.0	.34	.44	.44	.24	.25	.29	.35	.24	.26	.24
	14.0	.33	.51	.42	.23	.25	.34	.36	.28	.21	.18
	16.0	.29	.46	.46	.31	.31	.37	.37	.31	.20	.41
	17.3	.50	.65	.64	.46	.48	.48	.50	.50	.44	.32
Wheat	11.2	.36	.52	.51	.24	.26	.31	.35	.27	.20	.10
	13.0	.47	.52	.55	.25	.29	.35	.38	.35	.29	.14
	15.0	.50	.55	.51	.35	.37	.47	.46	.39	.27	.27
	15.7	.56	.68	.69	.41	.46	.48	.50	.45	.51	.33
Soybeans	7.1	.25	.39	.39	.24	.34	.29	.31	.25	.19	.21
	8.1	.32	.55	.52	.29	.38	.32	.37	.32	.19	.21
	9.8	.31	.47	.37	.28	.31	.33	.31	.29	.20	.18
	12.2	.36	.55	.52	.28	.36	.35	.44	.43	.23	.20
Barley	10.7	.23	.56	.50	.23	.29	.27	.32	.23	.20	.20
	12.3	.25	.55	.52	.21	.28	.28	.31	.28	.25	.17
	14.3	.24	.57	.51	.21	.28	.30	.32	.28	.29	.20
	16.4	.33	.62	.55	.30	.33	.34	.41	.35	.21	.34

TABLE A-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.	Poly-ethy-lene	Mild Steel C.R.	Gal-vanized Sheet Metal
Shelled Corn	7.5	.27	.41	.46	.24	.25	.27	.29	.22	.23	.20
	9.9	.25	.59	.62	.28	.31	.31	.31	.27	.20	.24
	12.2	.33	.68	.65	.26	.29	.33	.33	.30	.20	.25
	13.9	.35	.64	.54	.29	.36	.37	.38	.38	.24	.37
Alfalfa	82.0	.74	.69	.78	.61	.67	.70	.61	.61	.65	.54
	33.3	.48	.56	.71	.37	.48	.39	.49	.39	.51	.37
	22.2	.33	.65	.66	.31	.33	.33	.37	.32	.46	.36
Alfalfa 75% Timothy 25%	77.0	.63	.68	.78	.58	.60	.60	.70	.65	.65	.64
	26.2	.28	.49	.73	.31	.39	.36	.42	.33	.36	.38
	21.3	.26	.49	.62	.31	.36	.32	.39	.19	.35	.27
Alfalfa 25% Timothy 75%	81.1	.62	.69	.83	.52	.64	.66	.65	.62	.57	.59
	49.3	.51	.60	.82	.44	.56	.45	.59	.61	.43	.50
	21.6	.25	.53	.66	.31	.38	.37	.43	.23	.32	.29
Timothy	79.3	.58	.60	.77	.52	.53	.64	.60	.66	.57	.53
	38.1	.46	.59	.78	.51	.56	.53	.64	.52	.43	.32
	30.5	.37	.48	.73	.44	.38	.42	.52	.38	.39	.48
	16.7	.27	.45	.63	.35	.42	.40	.44	.21	.32	.32
Bedding Oat straw	14.95	.20	.36	.45	.20	.26	.22	.25	.22	.35	.30
Bedding Shavings	9.5	.35	.70	.73	.46	.53	.43	.51	.29	.57	.38
Corn Silage	78.4	.46	.56	.70	.58	.57	.57	.58	.40	.57	.49

TABLE A-II ANGLES OF REPOSE AND EQUIVALENT FLUID DENSITIES FOR SOME GRAINS*

Grain	Angle of Repose, degrees	Equivalent Fluid Densities (EFD), lb/cu ft
Barley	28	14.4 – 15.6
Corn, shelled	27	18.0
Flaxseed	25	17.5
Oats	32	10.3 – 10.8
Rye	26	18.1
Soybeans	29	16.1
Wheat		
Hard Red Winter	27	18.3
Soft Red Winter	27	19.2
Hard Red Spring	28	18.8

Note to Table A-II:

* *From* Grain storage loads, pressures and capacities, 1969 (see Bibliography)

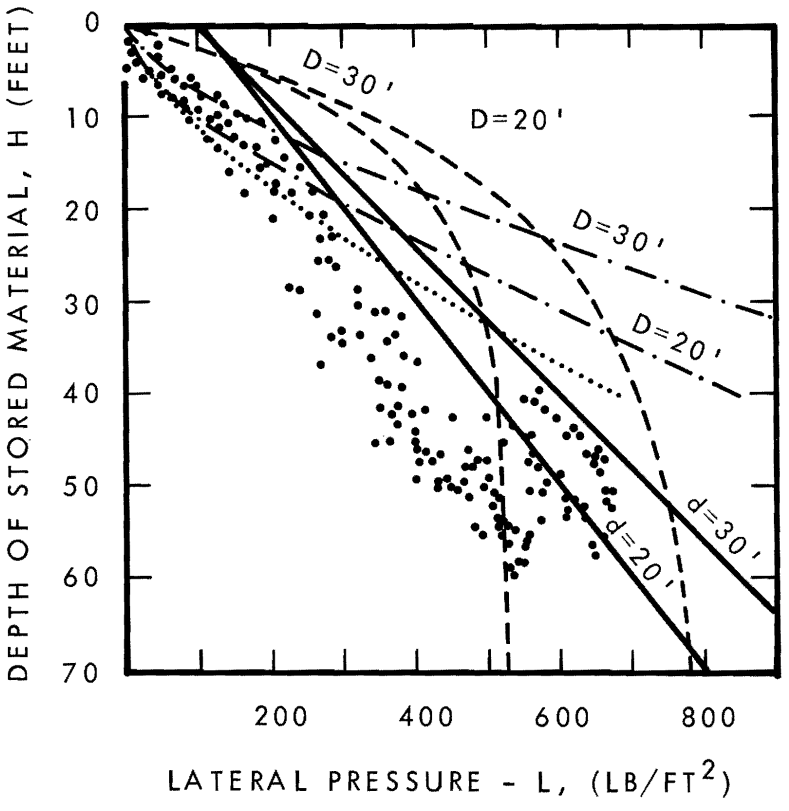


FIGURE 1-A

LATERAL PRESSURES FOR CORN SILAGE AND DRY SHELLED CORN

Janssen lateral bin pressure for shelled corn

$$L = \frac{WD}{4u'}\left(1 - e^{(-4Ku'\,H)/D}\right)$$

Where W = 45 pcf
u' = 0.423
K = 0.654

Formula from Subclause 1.1.2.1.(2) (d) (i)
$L = 100 + 1.92\ hd^{0.55}$

J.R. McCalmont, 1963 (see Bibliography)
For silage less than 74% moisture and D > 16ft

$$L = \frac{Dh^{1.45}}{5}$$

American Concrete Institute Standard
ACI 714-46 (rescinded 3 April 1967)

J.S. Boyd, 1961 (see Bibliography)

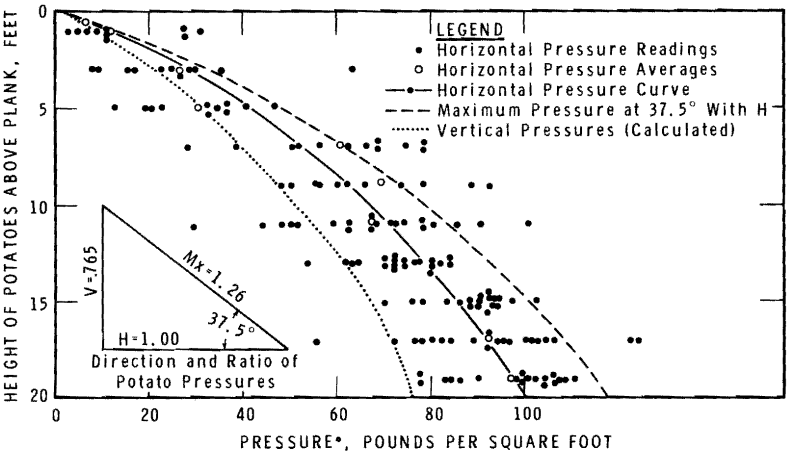


FIGURE 2-A
LOADS IMPOSED BY STORED POTATOES ON BIN WALLS**

Notes to Figure 2-A:

* The results were obtained in a deep bin as defined for stored grain in Appendix A. The bin was rectangular, 17 ft long by 9 ft 4 in. wide, with potatoes piled to a 20-ft height. The pressure measurements were recorded on the 9-ft 4-in. walls. (*From* A.D. Edgar, 1960; see Bibliography.)

** Maximum pressure curve plotted from pressure points, not shown. Vertical pressure based on calculations using horizontal and maximum deflections.

APPENDIX B

TABLES OF CONCRETE AND MORTAR MIXES

TABLE B-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 or 1 portland cement plus 1 hydrated lime	2¼ to 3 4½ to 6
Subject to extreme heavy loads, violent winds, or severe frost action, isolated piers	1 masonry cement plus 1 portland cement or 1 portland cement plus ¼ hydrated lime	4½ to 6 3 to 3¼

TABLE B-II GUIDE FOR ORDERING READY-MIXED CONCRETE

Specifications for medium consistency concrete (3-in. slump).	Flat Work (with 1½ in. maximum size aggregate)			Formwork (with ¾ in. maximum 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)
Minimum cement content, pound per cubic yard of concrete	660	565	470	725	610	515
Maximum water/cement ratio	0.45	0.55	0.60	0.45	0.55	0.60
Minimum compressive strength expected at 28 days, psi.	4,000	3,000	2,500	4,000	3,000	2,500
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 B-III RECOMMENDED CONCRETE MIXES FOR ON-THE-JOB MIXING

Kind of work	Gallons (imp.) 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, 80-lb	Aggregates		Approx. yield, cu ft
					Fine, cu ft	Coarse, cu ft	
3½ gallons (imp.) of water per bag of cement. Concrete subjected to severe wear, weather, or weak acid and alkali solutions	With ¾ in. max. size aggregate						
	3¼	2¾	2½	1	1¾	2	3.1
4¼ gallons (imp.) of water per bag of cement. Floors (such as basement, dairy barn) driveways, walks, septic tanks, storage tanks, structural beams, columns and slabs	With 1 in. max. size aggregate						
	4	3½	3	1	2	2½	3.7
	With 1½ in. max. size aggregate						
	4	3½	3	1	2¼	3	4.1
5 gallons (imp.) of water per bag of cement. Foundation walls, footings, mass concrete, etc.	With 1½ in. max. size aggregate						
	4½	4	3½	1	2½	3½	4.7

Notes to Table B-III

* 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 C

FIRE RESISTANCE RATINGS

TABLE C-I ESTIMATED FIRE RESISTANCE RATINGS FOR FRAME EXTERIOR WALLS*

	Description of Wall Materials and Construction	Fire Resistance, minutes
(1)	2 x 4 in. wood studs, 16 in. o.c. Inside finish**, 3/8 in. Douglas Fir plywood Outside finish, 3/8 in. exterior grade plywood only, or 5/16 in. exterior grade plywood plus building paper and metal, wood or ¼ in. hardboard siding.	25
(2)	Same as (1) except inside finish ½ in. Douglas Fir plywood, phenolic bonded.	30
(3)	Same as (1) except inside finish 5/8 in. Douglas Fir plywood, phenolic bonded.	35
(4)	Same as (1) except inside finish 3/8 in. Douglas Fir plywood, phenolic bonded, over 3/8 in. gypsum wallboard.	35
(5)	Same as (1) except, over 5/8 in. special fire retardant gypsum wallboard.***	60
(6)	Same as (1) except inside finish 3/16 in. asbestos cement board over 3/8 in. gypsum wallboard.	60
(7)	Same as (1) except add 3 in. mineral wool or glass fibre insulation between studs.	40
(8)	Same as (4) except add 3 in. mineral wool or glass fibre insulation between studs.	50

Notes to Table C-I:

* Ratings in this Table are based on the assumption of fire on the inside only. Outside cladding is required only to laterally support the studs and to restrict temperature rise and burn-through after the supporting studding has been exposed to fire by failure of the inside finishes.

** Ratings of frame interior walls should normally be based on fire on either side, and therefore should have finishes on both sides as per 'inside finish' requirements in this Table.

*** Fire retardant gypsum wallboard should be identified by Underwriters Laboratories' Fire Resistance Classification label.

TABLE C-II ESTIMATED FIRE RESISTANCE RATINGS FOR MASONRY WALLS

Description of Wall Materials and Construction	Fire Resistance, hours
(1) Cast-in-place concrete (Type N*), 1:2½:3½ mix-ratio with or without reinforcement, 6 in. thick.	3
(2) Same as (1) except 8 in. thick.	5
(3) Hollow concrete unit masonry (Type N*), 50% min. solid material by volume, 8-in. nominal thickness.	1
(4) Hollow concrete unit masonry (Type L**), 44% min. solid material by volume, 8 in. nominal thickness	3

Notes to Table C-II:

* Type N Concrete is that type in which the aggregate is cinders, broken brick, blast furnace slag, limestone, calcareous gravel or similar diverse material containing not over 30% of quartz, chert or flint ($S_1 0_2$).

** Type L concrete is that in which all the aggregate is lightweight, of expanded slag, expanded burned clay or shale, or pumice.

TABLE C-III ESTIMATED FIRE RESISTANCE RATINGS FOR FLOORS*

Description of Floor Materials and Construction	Fire Resistance, minutes
(1) Reinforced concrete slab, 4 in. of 2000 psi concrete, steel protected by ¾ in. of concrete.	75
(2) Same as (1) except 6 in. of concrete and steel protected by 1 in. of concrete.	120
(3) Wood joist floor, 2 in. nominal joist thickness, 5/8 in. Douglas Fir plywood on top.	10
(4) Wood joist floor, 2 x 10 in. joists 16 in. o.c., 2 ply of ¾ in. lumber on top. Ceiling finished with ¾ in. of plaster on metal lath fastened with barbed roofing nails 6 in. o.c.	60
(5) Same as (3) except ceiling finished with 2 layers of 3/8 in. gypsum wallboard nailed with 1½ in. nails having 3/16 in. heads, at 6 in. O.C.	30
(6) Solid wood laminated mill floor 4 in. nominal thickness, 3/8 in. plywood on top.	45

Note to Table C-III:

* Fire resistance ratings of floor assemblies are based on tests with fire below the floor. No ratings are published for a situation with fire above. Ratings in this Table are probably conservative, however, for the 'fire above' situation.

APPENDIX D

WATER SUPPLY

TABLE D-I FRICTION HEAD LOSS IN FEET OF WATER PER 100 FEET OF STEEL PIPE (Based on C= 100 in. Hazen-Williams formula)

Flow, gallons (U.S.) per min.	Nominal Pipe Size, in.							
	1/2	3/4	1	1¼	1½	2	2½	3
2	7.4	1.9						
4	27.0	7.0	2.14	0.57	0.26			
6	57.0	14.7	4.55	1.20	0.56	0.20		
8	98.0	25.0	7.8	2.03	0.95	0.33	0.11	
10	147.0	38.0	11.7	3.05	1.43	0.50	0.17	0.07
12		53.0	16.4	4.30	2.01	0.79	0.23	0.10
15		80.0	25.0	6.50	3.00	1.08	0.36	0.15
20		136.0	42.0	11.10	5.20	1.82	0.61	0.25
25			64.0	16.60	7.30	2.73	0.92	0.38
30			89.0	31.20	11.00	3.84	1.29	0.54

TABLE D-II FRICTION HEAD LOSS IN FEET OF WATER PER 100 FEET OF PLASTIC PIPE (Based on C= 150 in. Hazen-Williams formula)

Flow, gallons (U.S.) per min.	Nominal Pipe Size, in.						
	3/4	1	1¼	1½	2	2½	3
2	0.90	0.28	0.07				
4	3.28	1.02	0.25	0.12			
6	7.0	2.15	0.55	0.25	0.07		
8	11.8	3.6	0.97	0.46	0.14	0.05	
10	17.9	5.5	1.46	0.69	0.21	0.09	
15	37.8	11.7	3.07	1.45	0.44	0.18	0.07
20		19.9	4.2	2.47	0.74	0.30	0.12
25		30.0	7.9	3.8	1.11	0.46	0.16
30		42.0	11.1	5.2	1.55	0.65	0.23

TABLE D-III FRICTION HEAD LOSS IN FEET OF WATER PER 100 FEET OF TYPE L COPPER TUBING (Based on C= 130 in. Hazen-Williams formula)

Flow, gallons (U.S.) per min.	Nominal Tubing Size, in.						
	1/2	3/4	1	1¼	1½	2	2½
2	8.89	1.50	0.41				
4	32.0	5.40	1.48				
6	67.7	11.5	3.13	1.12			
8	116.0	19.5	5.35	1.92	0.82		
10	174.0	29.4	8.08	2.90	1.24	0.32	
12		41.2	11.3	4.04	1.73	0.45	
16		70.3	19.2	6.82	2.92	0.77	
20			29.0	10.4	4.46	1.16	0.40
25			43.9	15.7	6.74	1.75	0.61
30			61.4	22.1	9.44	2.45	0.85

TABLE D-IV FRICTION HEAD LOSS IN VALVES AND FITTINGS*

Nominal Size, in.	Equivalent Length in Feet of Straight Pipe For:					
	90° Standard Ell	45° Standard Ell	Tee, Side Flow	Coupling or Straight Run of Tee	Gate Valve Open	Globe Valve Open
½	2	1.2	3	0.6	0.4	15
¾	2.5	1.5	4	0.8	0.5	20
1	3	1.8	5	0.9	0.6	25
1¼	4	2.4	6	1.2	0.8	35
1½	5	3	7	1.5	1.0	45
2	7	4	10	2.0	1.3	55
2½	8	5	12	2.5	1.6	65
3	10	6	15	3.0	2.0	80

Note to Table D-IV:

* *From* ASHRAE Guide and Data Book, 1967, Applications, American Society of Heating, Refrigerating and Air-Conditionaing Engineers.

APPENDIX E

DESIGN BEARING PRESSURES

TABLE E-I DESIGN BEARING PRESSURES OF SOIL AND ROCK

(For buildings three storeys or less in height)

Type and Condition of Soil or Rock	Design Bearing Pressure, psf (1, 3, 4)
Cohesionless soils	
(see Section B, Appendix E, for definitions)	
Dense sand, dense sand and gravel	6,000
Compact sand, compact sand and gravel	3,000
Loose sand, loose sand and gravel	1,000
Very loose sand, very loose sand and gravel	(2)
Cohesive soils	
(see Section C, Appendix E, for definitions)	
Dense silt	3,000
Compact silt	2,000
Loose silt	(2)
Very stiff clay	6,000
Stiff clay	3,000
Firm clay	1,500
Soft clay	750
Very soft clay	(2)
Miscellaneous soils and rock	
(see Section E, Appendix E for definitions)	
Till, dense or hard	8,000
Till, compact or firm	3,000
Till, soft	(2)
Cemented sand and gravel	10,000
Clay shale	(2)
Filled ground	(2)
Rock	
(see Section F, Appendix E, for definitions)	
Without defects	Up to 20,000
With defects	(2)
Column 1	Column 2

Notes to Table E-I:

(1) Where records of successful local practice can show any of the values that appear in this Table to be either too high or too low, they may be altered by the authority having jurisdiction to suit local conditions.

(2) Design bearing pressures shall be determined by a special investigation.

(3) Where load test values or tabular values are used as provided for in Section 4.2, of the National Building Code of Canada 1970, the design capacity of a foundation is the bearing surface area times the design bearing pressure of the soil or rock at the bearing surface, reduced as may be necessary by the requirements contained in Subsection 4.2.3. of the National Building Code of Canada, 1970.

(4) For purposes of determining the vertical stress in soils or rock below the bearing surface the load from the foundation unit shall be assumed to be distributed uniformly over the area of any horizontal plane within a frustum extending downward from the foundation unit perimeter at 60° to the horizontal, but the area considered as supporting the load shall not extend beyond the intersection of 60° planes to adjacent foundation units.

DEFINITIONS

A. *Soil,* is that portion of the earth's crust which is fragmentary, or such that individual particles of a dried sample may be readily separated by agitation in water; it includes boulders, cobbles, gravel, sand, silt, clay and organic matter.

B. (1) A "cohesionless soil" identified as:

(a) "gravel," is a soil consisting of particles smaller than 3 in., but retained on a No. 4 sieve,

(b) "sand," is a soil consisting of particles passing a No. 4 sieve but retained on a No. 200 sieve.

(2) "Sands" are further subdivided as follows:

(a) "coarse sand" is a soil consisting of particles passing a No. 4 sieve but retained on a No. 10 sieve,

(b) "medium sand" is a soil consisting of particles passing a No. 10 sieve but retained on a No. 40 sieve, and

(c) "fine sand" is a soil consisting of particles passing a No. 40 sieve but retained on a No. 200 sieve.

(3) In addition, particles identified as:

(a) "cobbles" are rock fragments whose greatest dimension is between 3 and 8 in.

(b) "boulders" are rock fragments whose greatest dimension exceeds 8 in.

C. (1) A cohesionless soil described as

(a) "dense," requires 30 or more blows per foot in a penetration test,

(b) "compact," requires between 10 and 30 blows per foot in a penetration test,

(c) "loose," requires between 4 and 10 blows per foot in a penetration test,

(d) "very loose," requires less than 4 blows per foot in a penetration test

where the test is carried out in accordance with Specification A119.1-1960, Code for Split-Barrel Sampling of Soils, issued by the Canadian Standards Association.

(2) Where it is not possible to conduct a penetration test, a cohesionless soil may be described as

(a) "dense" if it is not possible for a man of average weight to push a wooden picket more than 1½ in. into the soil, and

(b) "loose" if it is possible for a man of average weight to push a wooden picket 8 in. or more into the soil.

(3) The picket referred to in (2) is 2 in. sq. nominal dimensions, bevelled at 45° on all sides at one end to form a point.

D. (1) A cohesive soil identified as

(a) "silt" is a soil

(i) the particles of which are not visible to the naked eye,

(ii) dry lumps of which are easily powdered by the fingers,

(iii) that, after shaking a small saturated pat vigorously in the hand, exhibits a wet shiny surface that disappears rapidly when the pat is subsequently squeezed, and

(iv) that does not shine when moist and stroked with a knife.

(b) "clay" is a soil

(i) the particles of which are not visible to the naked eye,

(ii) dry lumps of which are not easily powdered by the fingers,

(iii) that, after shaking a small saturated pat vigorously in the hand, does not exhibit a wet shiny surface, and

(iv) that shines when moist and stroked with a knife.

E. The consistencies of cohesive soils can be identified according to the description given in Table E-II and may be related to the approximate undrained shear strengths as indicated.

TABLE E-II IDENTIFICATION OF COHESIVE SOILS

Consistency	Description	Approximate undrained shear strength, psf
very stiff	is of a type impossible to indent with the thumb but readily indented with the thumbnail	Over 2000
stiff	is of a type difficult to indent with the thumb; with difficulty it can be remoulded by hand	1000 to 2000
firm	is of a type that can be indented by moderate thumb pressure	500 to 1000
soft	is of a type that can be penetrated several inches with the thumb	250 to 500
very soft	is of a type that can easily be penetrated several inches by the fist	less than 250

F. Organic soils and soils other than those identified in Articles 4.2.1.4 to 4.2.1.7. of the National Building Code of Canada, 1970 require special investigations.

G. (1) A soil or rock identified as

(a) "clay-shale" is fine-grained, finely laminated, will swell on wetting and will disintegrate on its first drying and wetting cycle,

(b) "till," is of glacial origin, unsorted and heterogeneous and can contain a range of particle sizes from boulders, cobbles, gravel, sands, silts and clays and can exist at any relative density of consistency,

(c) "cemented sand and gravel," is a mixture of sand and gravel or boulders thoroughly cemented together as a hard layer which will not soften in its natural bed.

H. (1) Rock is that portion of the earth's crust which is consolidated, coherent and relatively hard, and is a naturally formed mass of mineral matter which cannot be readily broken by the hands.

(2) Rocks vary from "hard" through "medium hard" to "soft."

(a) "hard" means rock comparable to concrete with a compressive strength greater than 6000 psi,

(b) "medium hard" means rock comparable to concrete with a compressive strength greater than 2500 psi,

(c) "soft" rock is comparable to brick masonry with a compressive strength greater than 500 psi.

(3) Rocks are classified as

(a) igneous such as granite, diorite, basalt,

(b) sedimentary such as sandstones, shales, limestones,

(c) metamorphic such as quartzites, slates, marbles, schists.

(4) Rocks may contain defects. Defects which adversely affect the bearing capacity are:

(a) closely spaced, or open, or steeply inclined bedding planes, joints, fault zones, fractures or shear planes.

(b) unsoundness, such as closely spaced seams of clay, fault gouge, soil or softened rock, cavities,

(c) significant alteration of the strength of the rock by weathering, decomposition or disintegration in the mass or in part,

(d) slaking or swelling behaviour in water.

(5) Some natural materials which geologically may be correctly referred to as rocks are to be treated as soil under the provisions of this Code. These materials are:

(a) soft rocks with adverse defects,

(b) very weakly cemented sedimentary or soft metamorphic rocks which can be scratched by the finger nail,

(c) any material which can be dug by hand with a shovel or a a pneumatic spade,

(d) cemented sands and gravels in which the cementing may be sporadic.

APPENDIX F

UNIT WEIGHTS OF MATERIALS

TABLE F-I UNIT WEIGHTS OF CONSTRUCTION MATERIALS AND COMPONENTS

Materials and Components	Unit Weight,
MATERIALS	lb/cu ft
Cast stone masonry	144
Cinder fill	57
Concrete–	
plain	144
structural lightweight concrete	90-115
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
COMPONENTS	lb/sq ft
Shingle 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–	
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 F-I (Cont'd)

Materials and Components	Unit Weight,
COMPONENTS (cont'd)	lb/sq ft
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
Lightweight aggregate	8
Wood-joist floors 16 in.;	
double wood floor 2 in.	
2 x 5 joists	5
2 x 6 joists	6
2 x 10 joists	6
2 x 12 joists	7
Roof coverings–	
aluminum	1/3
asbestos shingles	4
asphalt shingles	6
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
3/8	1.2
1/2	1.5
5/8	1.8
3/4	2.2
Phenolic bonded particleboard (thickness in inches)–	
1/4	0.833
5/16	1.041
3/8	1.25
1/2	1.666
5/8	2.083
3/4	2.5
Farm Truss Roof Construction – Dead Loads	
A – Trusses (4 ft. o.c.)	
– Metal roofing	
– No ceiling	4.2
B – Trusses (4 ft. o.c.)	
– Metal roofing	
– Insulation and plywood ceiling	5.7
C – Trusses (4 ft. o.c.)	
– Asphalt shingles – lumber sheathing	
– Insulation and plywood ceiling	9.2

TABLE F-II APPARENT DENSITIES OF AGRICULTURAL MATERIALS

Material	Apparent Density lb/cu ft	Remarks
Grains–		
Barley	40	
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	
Corn–		
shelled, 15.5% moisture	45*	
24 % moisture	46	
28 % moisture	46.6	
32 % moisture	47.4	
ground shelled, 15.5%	51	Grinding and deep storage increases density approximately 14% over shelled corn.
husked ear corn	28	2 cu ft of ear corn yields approximately 1 cu ft of shelled corn.
ground ear corn	36	
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	
Roughage Feeds and Bedding–		
Hay		
–long	4-5	(use higher values for hay to be dried artificially)
–chopped	8-10	
–baled	6-14	
–wafered	20	

TABLE F-II (Cont'd)

Material	Apparent Density, lb/cu ft	Remarks
Silage		
–stored 8 ft deep, average	35	Moisture content** of 70% wet basis
–stored 30 ft deep, average	41	
–stored 40 ft deep, average	47	
–stored 50 ft deep, average	51	
–stored 60 ft deep, average	56	
–stored 70 ft deep, average	60	
–stored 80 ft deep, average	64	
Straw		
–long	3.5-4	
–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	65-70	
Portland cement	87-94	
Coal		
–anthracite	47-58	
–bituminous	40-54	

Notes to Table F-II:

* A standard 'bushel' is 56 lb of shelled corn at 15.5% moisture, and occupies approximately 1.25 cu ft. Increasing moisture content increases both weight and volume of shelled corn.

** To calculate apparent densities at other moisture contents use the following formula:

$$D = [0.30(D_{70})]/1\text{-}m$$

where D = other apparent density, lb/cu ft.

D_{70} = apparent density at 70% wet basis

M = other moisture content, $\frac{\%\ \text{moisture}}{100}$, wet basis

= wt. of water / wt. of wet silage

APPENDIX G

FARM VEHICLE AND EQUIPMENT STORAGE

TABLE G-I AREAS AND DIMENSIONS OF FARM VEHICLES AND EQUIPMENT

Item	Length*, ft	Width, ft	Height, ft	Occupied Area**, sq ft
Automobile	18	7	6	126
Bale elevator, wheeled, 40 ft	40	7½		80
Bale stooker–	6	5½	3½	33
Bale wagon, PTO	26½	10½	11½	
Bale wagon, SP	25	12	11½	
Baler	19½	10½	5½	100
Baler, self-propelled	17	10½	8½	
Combine, PTO	30	nominal width + 5	12½	250
Combine, SP	29	nominal width+1½	13½***	300
Corn picker				
1-row, pull type	10	8	10½	80
2-row, pull type	14	11	10½	132
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
6-row, tractor-drawn	12	14	5	
8-row, tractor-drawn (narrow spacing)	12	14	4½	
Cultivator, field				
8 ft. tractor-mounted	4	8		25
10 ft. tractor-mounted	6½	10		48
16 ft. tractor-mounted wheel type	13	16		
20 - 22 ft, tractor-drawn	14 to 17	17 to 19	9	240
26 - 28 ft, tractor-drawn	16	13 to 15	12 to 15	240
Cultivator, row-crop				
2-row, tractor-type demounted				55
4-row	8	15		100
Disc, one-way	14	9		
Discer				
Discer (transport) nominal width+ 10 ft		9½	4	
Duplex (transport) nominal width+ 12 ft		11	4	
Disc harrow–				
8-ft, tractor-mounted	9½	9	2½	60
8-ft, transport-wheel type	10	9		65
13-ft, transport-wheel type	13	14½	3½	

TABLE G-I (Cont'd)

Item	Length*, ft	Width, ft	Height ft	Occupied Area**, sq ft
Feed grinder, mixer unit				
tractor-drawn, PTO driven	12½	8½	8 ⅔	70
Forage harvester				
tractor-drawn, 2-row corn head	19½	11	11	136
windrow pickup attachment	6	6	4	27
self-propelled	18	11	11	
Forage blower, in transport position				
long hopper type	15½	6	6	80
short hopper type	8½	5½	6	47
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	12 ⅔	6	80
24 x 7, tractor-drawn	11	18	6	140
Hay conditioner	9	9	4	42
Liquid manure tanker–				
800 U.S. gal.	12	7	7½	84
1,400 U.S. gal.	14	8	8½	112
Manure Loader, removed from tractor	9	4		36
Manure spreader, tractor, 125 bu.	18½	6½	5½	100
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
7-ft bar down	8	14	3½	
7-ft bar up	8	7	9	
9-ft bar down	8	16	3½	
9-ft bar up	8	7	11	
Mower conditioner	12	11½	4	
Plow, tractor-drawn				
two-furrow mounted	5	3		12
five-furrow semi-mounted	21	7		
six-furrow semi-mounted	21	5½		
seven-furrow semi-mounted	25	9½		
Potato digger	8	5		40
1-row	27	12	10	175
2-row	27	15	10	200

TABLE G-I (Cont'd)

Item	Length*, ft	Width, ft	Height ft	Occupied Area**, sq ft.
Potato harvester				
1-row	27	12	10	175
2-row	27	15	10	200
2, 3 or 4-row (bulk loader in transport position)	25	13	11½****	250
Potato sprayer	13	8½	7	110
Potato planter				
1-row	8½	4	5	24
2-row	8½	6	5	36
4-row	12	13	5¼	120
Rake				
12-ft dump rake, horse-drawn	14	14	4½	80
side delivery, tractor-drawn	12	12½	4½	108
rake (reel)	11	11½	4½	
rake (wheel) 6 wheels	14	13	4½	
Rotary-hoe	6	10	3	50
Stalk shredder				
vertical shaft, single rotor, mounted	7	6	3	37
horizontal shaft, with hood, wheeled	9½	9½	10	75
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
Tractor				
2 to 3 plow	10	6⅙	6⅔	
3 to 4 plow	13	6½	8⅙	
3 to 4 plow, row-crop type	12½	7½	7½	70
5 plow	13	8*****	9***	
6 plow	13½	8*****	9½***	
7 plow	14	8½*****	10***	
8 plow	14½	8½*****	10***	
8 plow 4 wheel drive	18½	8½*****	10***	
Truck				
pickup, 6½-ft box	16	6½	6	104
pickup, 8-ft box	17½	6½	6	114
livestock rack	26	8	11	208
grain bed	26	8	9	208
Utility blade, tractor rear-mounted	3½	6		12

TABLE G-I (Cont'd)

Item	Length*, ft	Width, ft	Height ft	Occupied Area**, sq ft
Wagon				
flat platform	16	8	3	128
self-unloading all-purpose wagon	22½	8½ (without side extn.)	11	160
self-unloading all-purpose wagon (with cover)	22½	8½	13	
V-botton auger wagon (125 bu.)	10	6	12 (with 9 ft auger)	54
hoppered grain wagon	10½	7	7 (with 1 ft. side extn)	75
Wheeled fertilizer spreader				
8-ft. spreading width	7	9⅔		48
10-ft. spreading width	7	11⅔		58
Windrower, PTO	14	nominal width + 5	5	
Windrower, SP	18	nominal width + 1½	8	

Notes to Table G-I:

* 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.

*** Add 2 ft for cab.

**** With pneumatic stone separator.

***** Duals extra.

APPENDIX H

JANUARY DESIGN TEMPERATURES (5 PER CENT BASIS)

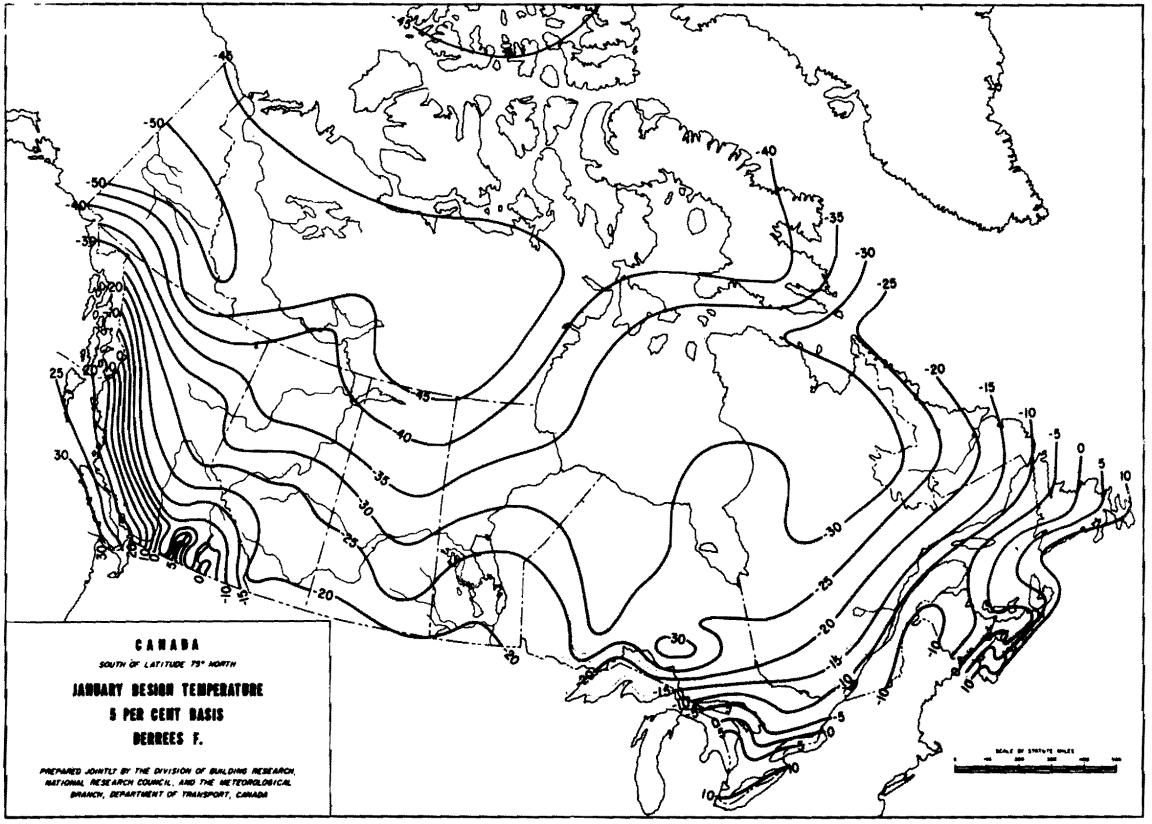


FIGURE 1-H

JANUARY DESIGN TEMPERATURE (5 PER CENT BASIS)

APPENDIX I

HEAT AND MOISTURE PRODUCTION OF LIVESTOCK

TABLE I-I OPTIMUM TEMPERATURE RANGE, HEAT AND MOISTURE PRODUCTION OF RABBITS

Temperature range	50° to 60°F
Sensible heat production (per 5-lb wt)	30 to 40 Btu/hr
Moisture production (per 5-lb wt)	100 to 150 grains/hr

TABLE I-II HEAT PRODUCTION OF BROILER CHICKENS*

Dry-Bulb Temperatures Decreasing From 92.2 to 85.9 During Growth							
Age, days	2	11	20	33	40	55	62
Sensible Heat**	6.0	17.7	15.1	11.0	8.2	6.8	6.1
Latent Heat**	6.0	4.1	3.4	3.4	2.6	2.8	2.2
Total Heat**	12.0	21.8	18.5	14.4	10.8	9.6	8.3
Dry-Bulb Temperatures Decreasing From 95.2 to 53.3 During Growth							
Age, days	3	14	20	31	40	50	
Sensible Heat**	16.7	23.0	17.9	13.1	11.3	13.9	
Latent Heat**	1.1	3.3	2.6	2.8	2.7	2.3	
Total Heat**	17.8	26.3	20.5	15.9	14.0	16.2	

Notes to Table I-II:

* *From* H. Ota and E.H. McNally, 1965 (see Bibliography)

** Btu per (hr) (lb of live weight)

TABLE I-III HEAT PRODUCTION OF SHORTHORN HEIFERS GROWING AT 50°F AND 80°F

Age, months		Weight, lb	Heat Production			
			at 50°F*		at 80°F	
At 50°	At 80°		Total Heat** (Btu/Animal-hr)	Latent/Total*** Ratio	Total Heat** (Btu/Animal-hr)	Latent/Total*** Ratio
2	2.3	110	163	.27	147	0.54
5	7.1	276	343	.25	309	.49
8.5	12.9	496	411	.25	378	.53
12.2	16.4	661	452	.25	425	.57
16.4		827	486	.26		
17.7		882	497	.26		

Notes to Table I-III:

* data for 50° taken at approximately 62 per cent relative humidity.

** *From* H.H. Kibler, 1957 (see Bibliography).

*** *From* H.H. Kibler and R.G. Yeck, 1959 (see Bibliography).

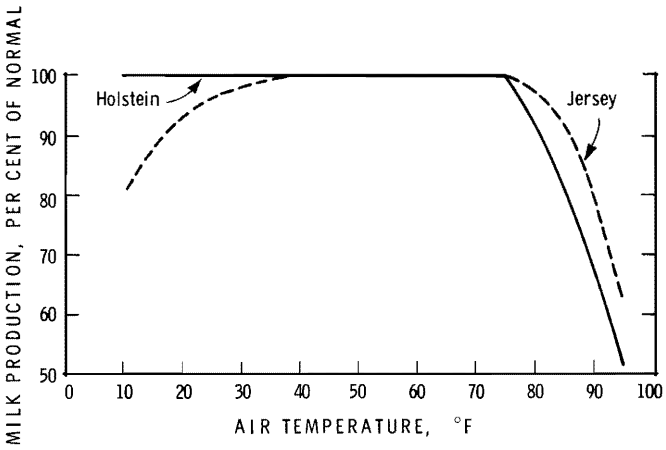


FIGURE 1-I

MILK PRODUCTION VERSUS TEMPERATURE*

Note to Figure 1-I:

* *From* R.G. Yeck and R.E. Stewart, 1959 (see Bibliography). (Per cent of normal milk production at various environmental temperatures. The relative humidity ranged from 55 to 70 per cent.)

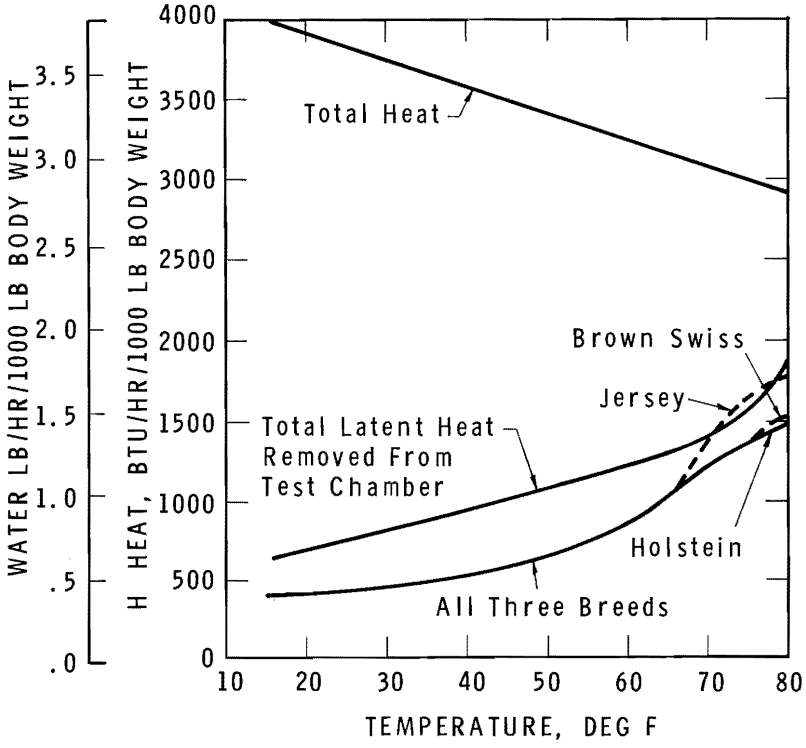


FIGURE 2-I
TOTAL AND LATENT HEAT PRODUCTION OF CATTLE*

Note to Figure 2-I:
* *From* R.G. Yeck and R.E. Stewart, 1959 (see Bibliography)

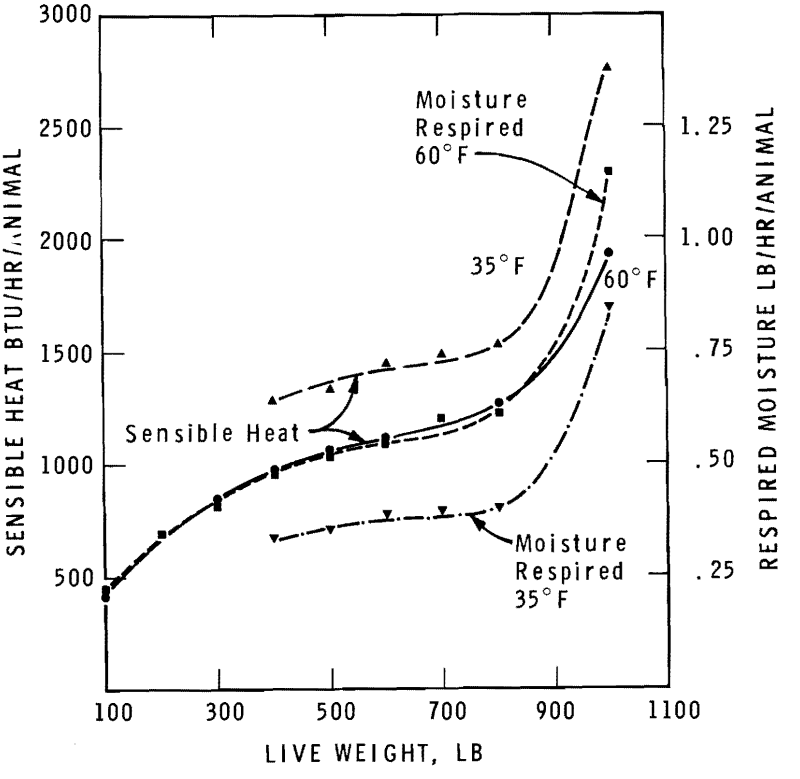


FIGURE 3-I
HEAT AND MOISTURE PRODUCTION FROM GROWING CATTLE, WINTER CONDITIONS

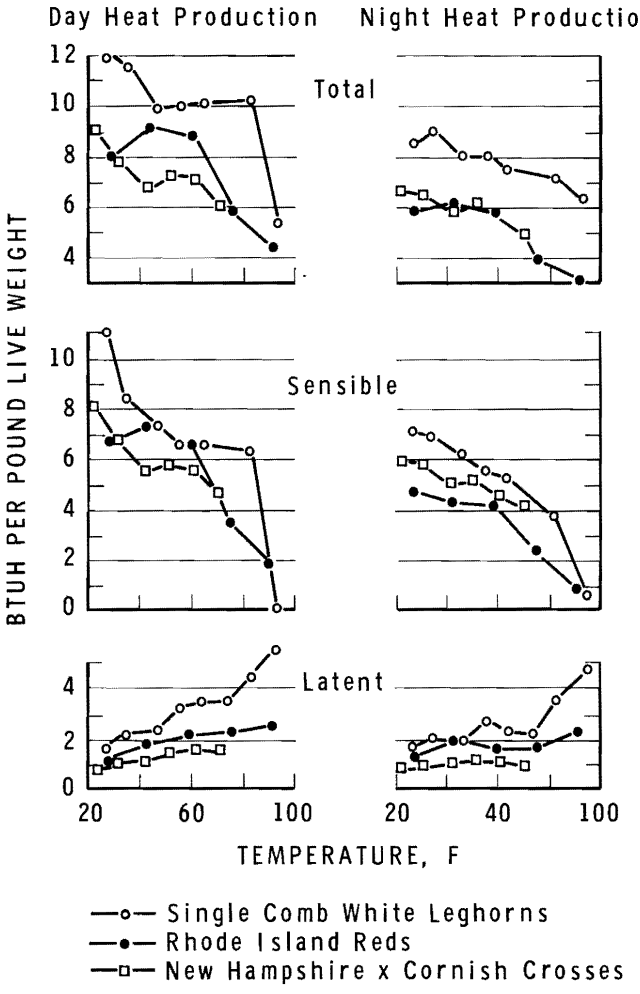


FIGURE 4-I

HEAT AND MOISTURE LOADS FOR CAGED LAYING HENS AT VARIOUS AIR TEMPERATURES*

Note to Figure 4-I:

* *From* H. Ota and E.H. McNally, 1961 (see Bibliography)

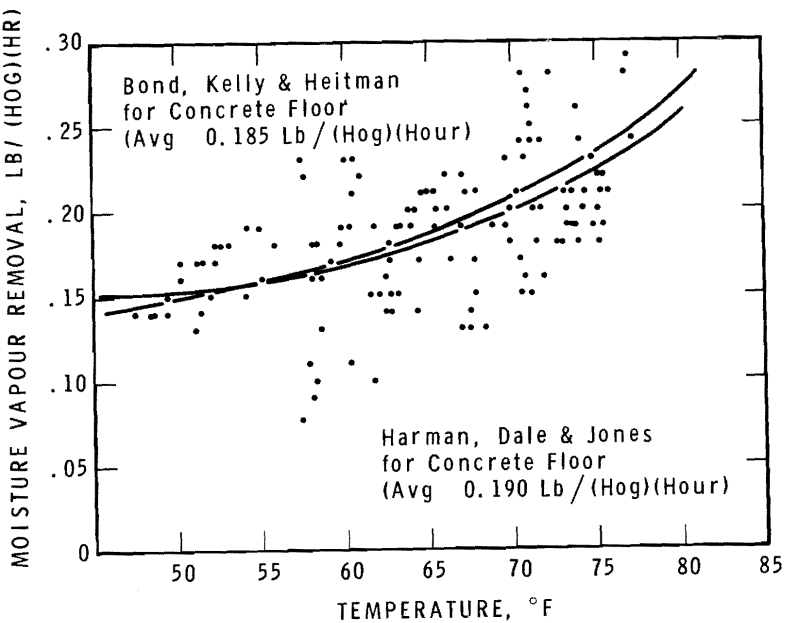


FIGURE 5-I
MOISTURE-VAPOUR REMOVAL RATE VERSUS TEMPERATURE FOR CONCRETE FLOOR PEN*

Note to Figure 5-I:
* *From* D.J. Harman, A.C. Dale and H.W. Jones, 1968 (see Bibliography)

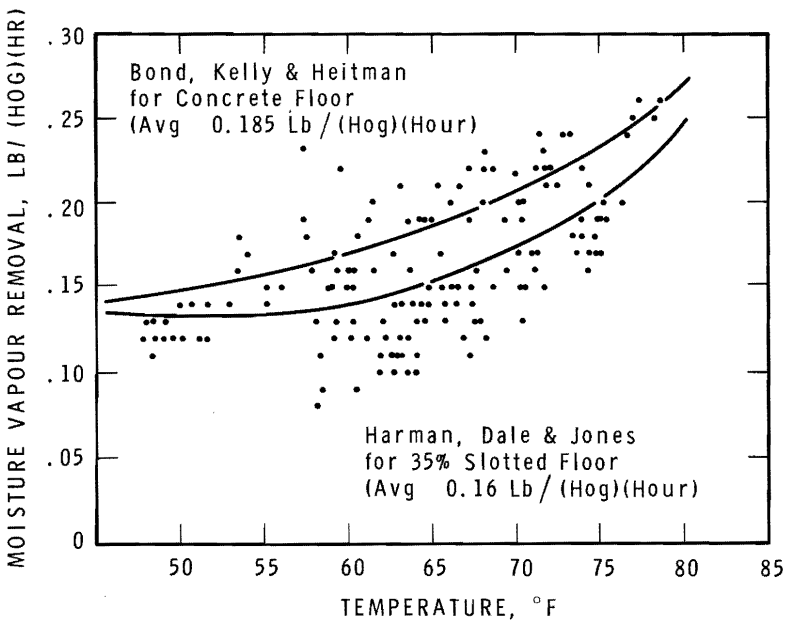


FIGURE 6-I
MOISTURE-VAPOUR REMOVAL RATE VERSUS TEMPERATURE FOR PARTIAL SLOTTED FLOOR PEN*

Note to Figure 6-I:
* *From* D.J. Harman, A.C. Dale and H.W. Jones, 1968 (see Bibliography)

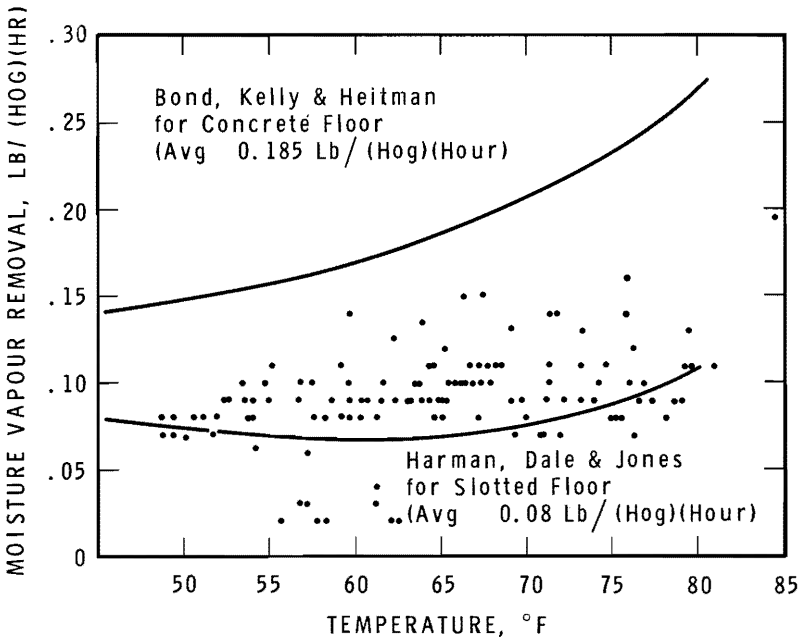


FIGURE 7-I
MOISTURE-VAPOUR REMOVAL RATE VERSUS TEMPERATURE FOR SLOTTED FLOOR PEN*

Note to Figure 7-I:

* *From* D.J. Harman, A.C. Dale, and H.W. Jones, 1968 (see Bibliography)

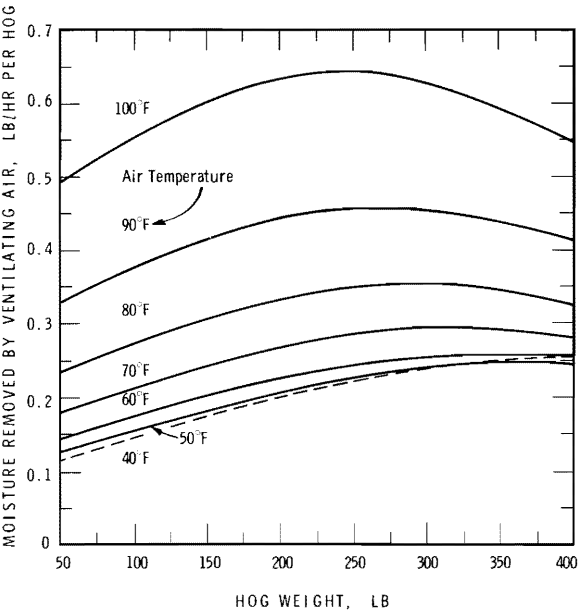


FIGURE 8-I
TOTAL MOISTURE REMOVED BY VENTILATION SYSTEM OF TEST ROOM HOUSING SWINE

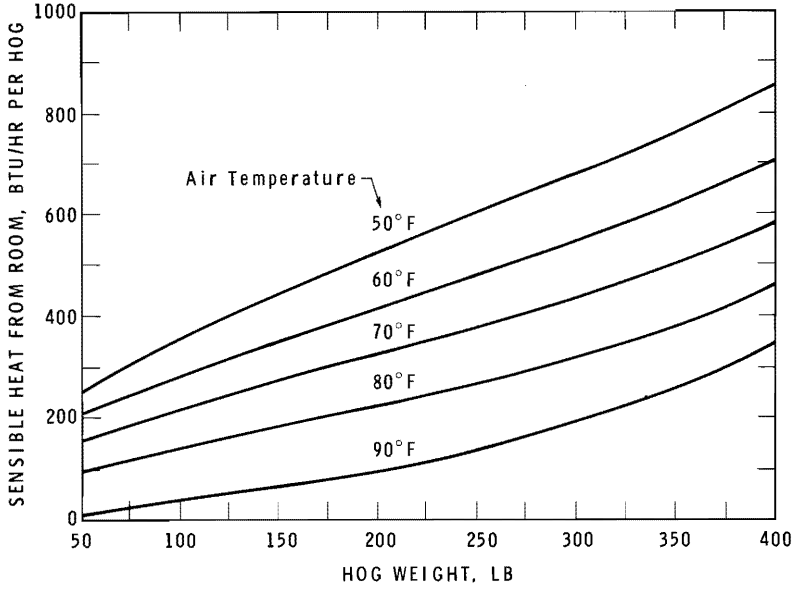


FIGURE 9-I
CURVES FOR ESTIMATING THE ROOM SENSIBLE HEAT IN A HOG HOUSE ON THE BASIS OF ANIMAL SIZE AND ROOM TEMPERATURE*

Note to Figure 9-I:
* *From* T.E. Bond, C.F. Kelly and H. Heitman Jr., 1959 (see Bibliography)

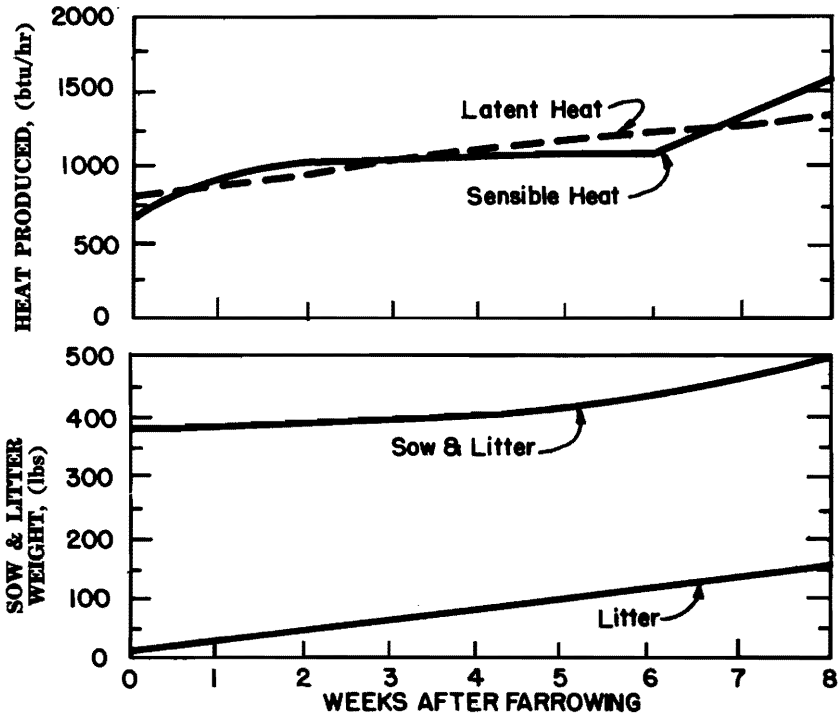


FIGURE 10-I
BUILDING SENSIBLE AND LATENT HEAT, AND ANIMAL WEIGHT FOR SOWS AND LITTERS*

Note to Figure 10-I:

* *From* T.E. Bond, C.F. Kelly and H. Heitman Jr., 1952 (see Bibliography). (Heat and moisture production were measured at environmental temperatures of 50, 60, and 70°F and then averaged.)

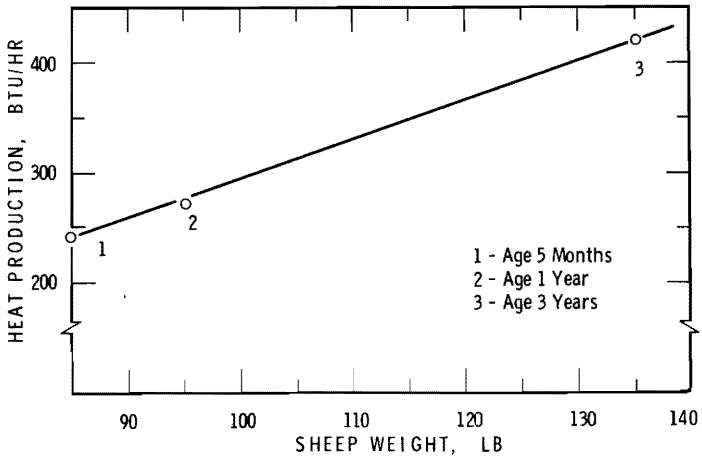


FIGURE 11-I
EFFECT OF SHEEP WEIGHT UPON HEAT PRODUCTION AT AIR TEMPERATURE OF 70 TO 72°F

Note to Figure 11-I:

* *From* E.G. Reitzman and F.G. Benedict, 1930; E.G. Reitzman and F.G. Benedict, 1931; and D.G. Armstrong et al, 1959 (see Bibliography)

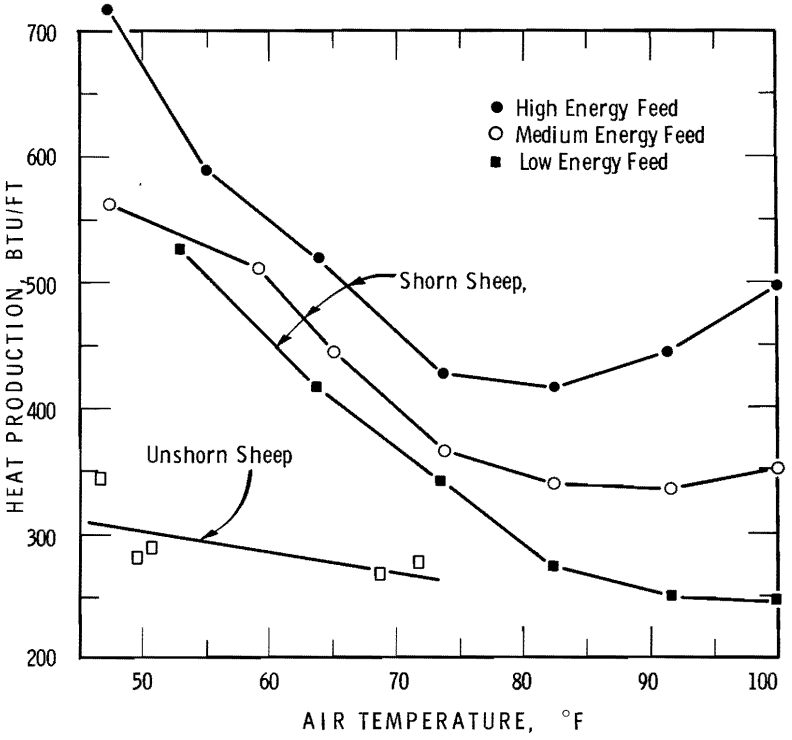


FIGURE 12-I

EFFECT OF AIR TEMPERATURE UPON HEAT PRODUCTION OF SHEEP*

Note to Figure 12-I:

* *From* E.G. Reitzman and F.G. Benedict, 1930; E.G. Reitzman and F.G. Benedict, 1931; and D.G. Armstrong et al, 1959 (see Bibliography)

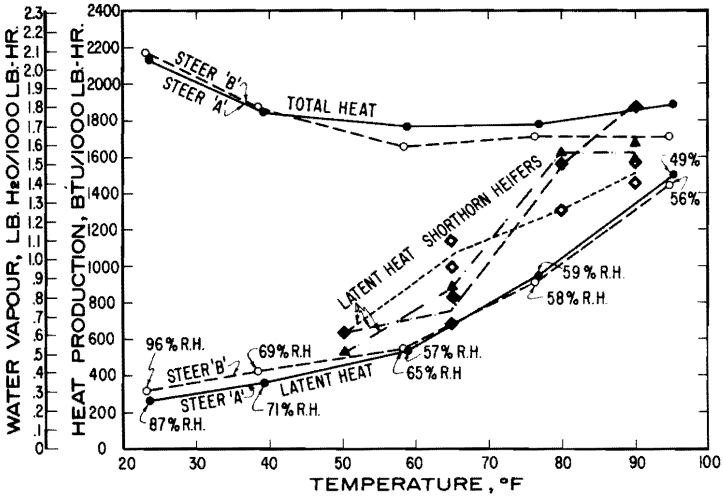


FIGURE 13-I
TOTAL AND LATENT HEAT PRODUCTION OF STEERS IN RELATION TO TEMPERATURE*

Note to Figure 13-I:

* (Curves for Steer 'A' and Steer 'B' were redrawn from the paper by K.L. Baxter and F.W. Wainman, 1961, see Bibliography. Steers were Aberdeen Angus on maintenance ration and weighed between 1120 and 1175 lb each. Latent heat curves for Shorthorn heifers were redrawn from the paper by H.H. Kibler and R.G. Yeck, 1959, see Bibliography.)

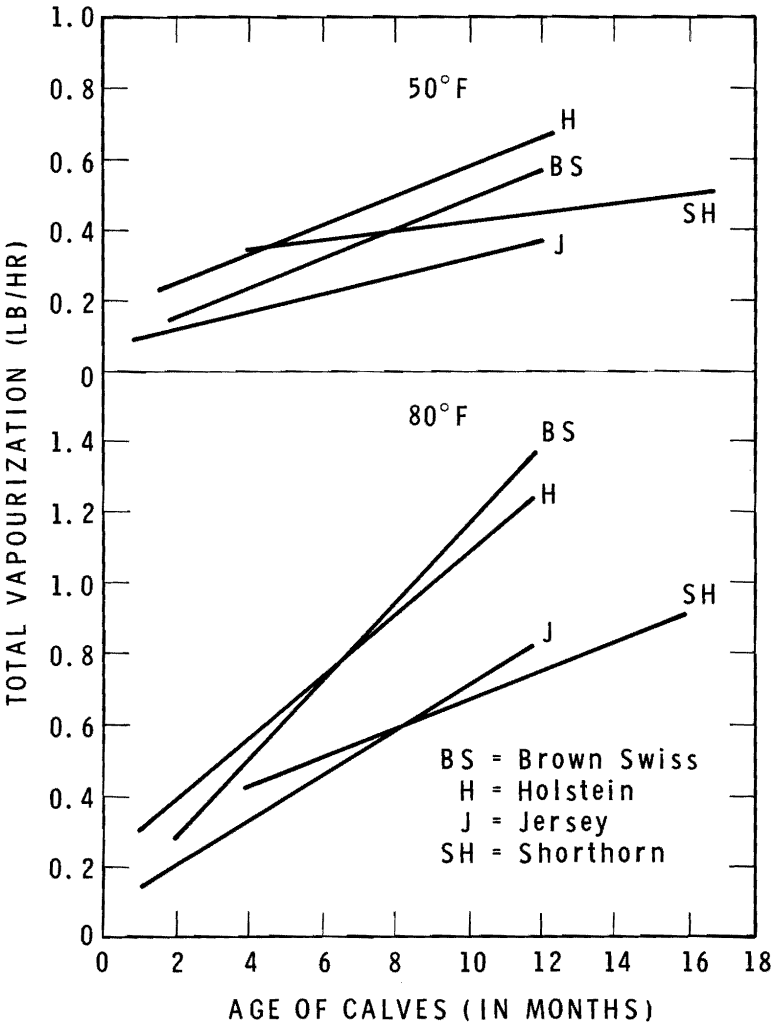


FIGURE 14-I

TOTAL VAPOURIZATION RELATED TO AGE, FOR HOLSTEIN, JERSEY, BROWN SWISS, AND SHORTHORN CALVES GROWN AT 50° AND 80°F*

Note to Figure 14-I:

* *From* H.H. Kibler, R.G. Yeck, and I.L. Berry, 1962 (see Bibliography)

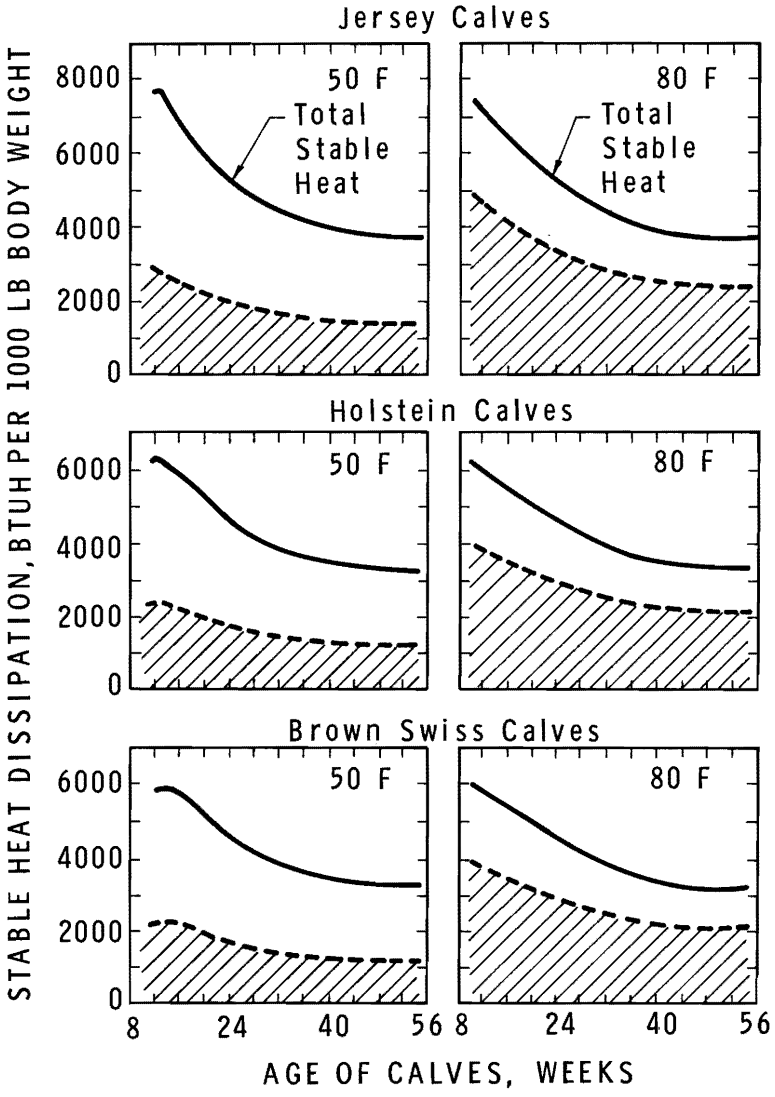


FIGURE 15-I
STABLE HEAT (TOTAL HEAT) AND LATENT HEAT PRODUCED BY DAIRY CALVES*

Notes to Figure 15-I:

(Relative humidities were approximately 70% at 50° and 50% at 80°. Calves were housed in pens cleaned daily.)

* *From* R.G. Yeck and R.E. Stewart, 1960 (see Bibliography)

APPENDIX J

HEAT OF RESPIRATION OF STORED PRODUCTS

TABLE J-I HEAT OF RESPIRATION OF VEGETABLES

PRODUCT	Average Freezing Point, °F	Per cent Water	Specific Heat, 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	5,800
						40	10,600
Beans, Lima	30.1	66.5	0.73	0.40	94	32	2,350
						40	5,000
						60	25,000
Beans, dried		12.5	0.30	0.24	18	–	–
Beets	26.9	90	0.86	0.47	129	32	2,650
						40	4,060
						60	7,200
Broccoli	29.2	89.9	0.92	0.47	130	32	7,450
						40	17,000
						60	50,000
Brussels sprouts	31	84.9	0.88	0.46	122	–	–
Cabbage	31.2	92.4	0.94	0.47	132	32	1,200
						40	1,700
						60	4,100
Carrots	29.6	88.2	0.86	0.45	126	32	2,130
						40	3,470
						60	8,100
Cauliflower	30.1	91.7	0.93	0.47	132	32	2,000
						40	4,500
						60	10,000

Celery	29.7	93.7	0.95	0.48	135	32	1,620
						40	2,420
						60	8,200
Corn (green)	28.9	75.5	0.80	0.43	108	32	9,000
						40	12,000
						60	38,000
Corn (dried)	—	10.5	0.28	0.23	15	–	–
Cucumbers	30.5	96.1	0.97	0.49	137	32	1,700
						40	2,500
						60	6,000
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	–	–
Kohlrabi	30	90	0.92	0.47	128	–	–
Lettuce	31.2	94.8	0.96	0.48	136	32	11,320
						40	15,990
Lettuce (leaf)						32	4,500
						40	6,400
						60	14,000
Mushrooms	30.2	91.1	0.93	0.47	130	32	6,200
						40	12,000
						60	46,000
Onions	30.1	87.5	0.91	0.46	124	32	1,000
						40	1,800
						60	2,400
Parsnips	30	78.6	0.84	0.46	112	–	–

Table J-I (Cont'd)

PRODUCT	Average Freezing Point, °F	Per cent Water	Specific Heat, Btu/lb, °F		Latent Heat of Fusion Btu/lb	Heat of Respiration	
			Above Freezing	Below Freezing		°F	Btu per (24 hr) ton
Peas (green)	30	74.3	0.79	0.42	106	32	8,400
						40	16,000
						60	44,000
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
Potatoes (mature)						32	700
						40	1,800
						60	2,600
Pumpkin	30.1	90.5	0.92	0.47	130	–	–
Radishes	29.5	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	32	5,000
						40	11,000
						60	38,000
Squash	29	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	32	1,000
						40	1,300
						60	5,600
Turnips	30.5	90.9	0.93	0.40	137	32	1,900
						40	2,200
						60	5,300
Vegetables (mixed)	30	90	0.90	0.45	130	–	–

TABLE J-II HEAT OF RESPIRATION OF MISCELLANEOUS FARM PRODUCTS AND BYPRODUCTS

PRODUCT	Average Freezing Point, °F	Per cent Water	Specific Heat, 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	–	–	–	–	–	–

TABLE J-III HEAT OF RESPIRATION OF STORED FRUITS*

PRODUCT	Average Freezing Point, °F	Per cent Water	Specific Heat, 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	900
						40	1,600
						60	7,000
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	32	2,000
						40	3,500
						60	10,000
Cantaloupes	29	92.7	0.94	0.48	132	40	3,470
						60	8,080
Cherries	26	83	0.87	0.45	120	32	1,700
						40	2,500
						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	32	600
						40	1,200
						60	3,500
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	1,300
						40	2,000
						60	9,000

TABLE J-III (Cont'd)

PRODUCT	Average Freezing Point, °F	Per cent Water	Specific Heat, Btu/ lb, °F		Latent Heat of Fusion, Btu/lb	Heat of Respiration	
			Above Freezing	Below Freezing		°F	Btu per (24 hr) ton
Pears	28.5	83.5	0.86	0.45	118	32	900
						40	1,700
						60	10,000
Plums	28	85.7	0.88	0.45	123	32	700
						40	1,500
						60	2,800
Raspberries	30.1	82	0.85	0.45	122	32	5,000
						40	8,000
						60	22,000
Strawberries	29.9	90	0.92	0.47	129	32	3,800
						40	6,800
						60	20,000
Watermelons	29.2	92.1	0.97	0.48	132	–	–

Notes to Table J-III:

* *From* The Commercial Storage of Fruits, Vegetables and Florist and Nursery Stocks, U.S.D.A. Agricultural Handbook No. 66, 1954.

APPENDIX K
VENTILATION

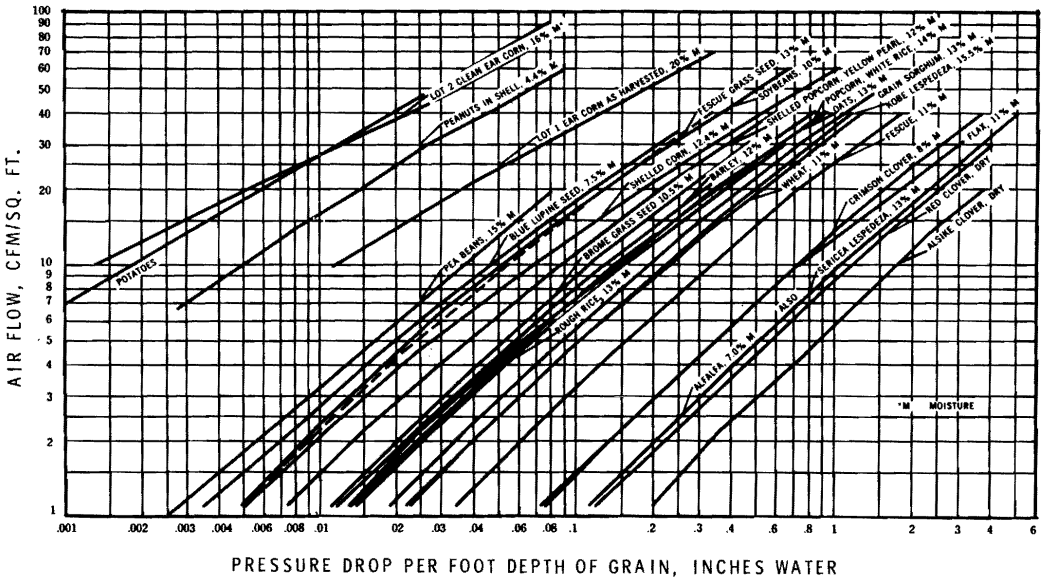


FIGURE 1-K
RESISTANCE OF GRAINS AND SEEDS TO AIR FLOW

Notes to Figure 1-K:

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 (inequilibrium 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.

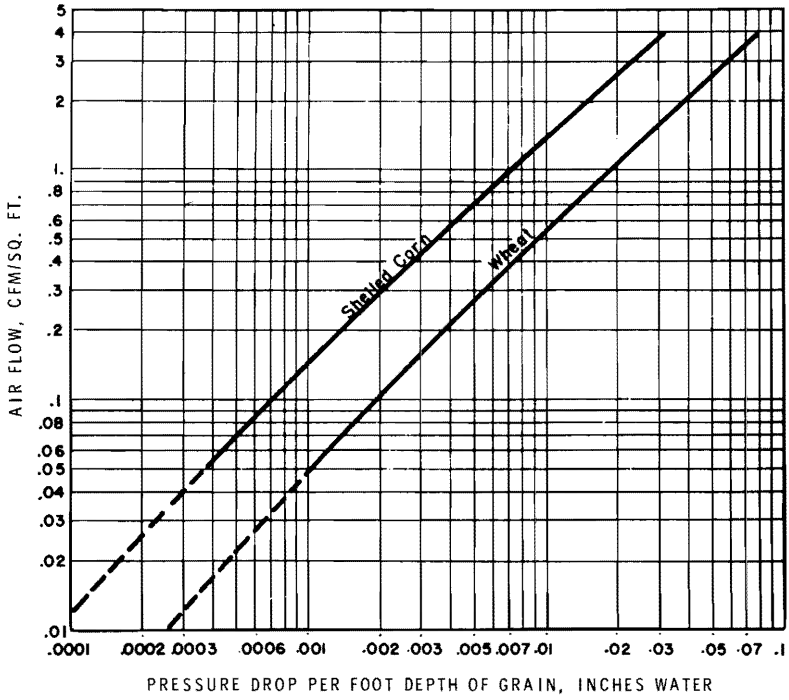


FIGURE 2-K

RESISTANCE OF SHELLED CORN AND WHEAT TO LOW AIR FLOWS

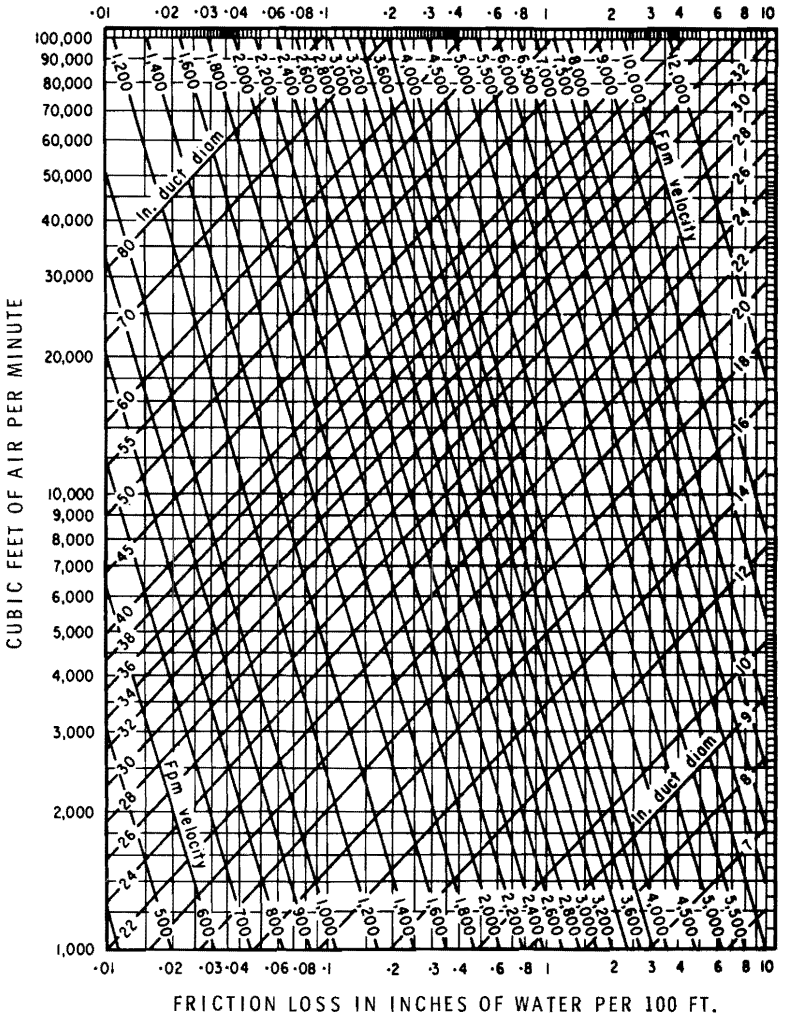


FIGURE 3-K

FRICTION OF AIR IN STRAIGHT DUCTS, 1000 TO 100,000 CU FT OF AIR PER MINUTE

Notes to Figure 3-K:

Based on standard air of 0.075 lb per cu ft density flowing through average, clean, round, galvanized metal ducts having approximately 40 joints per 100 ft. No safety factor included.

Caution: Do not extrapolate below chart (see Figure 4-K.)

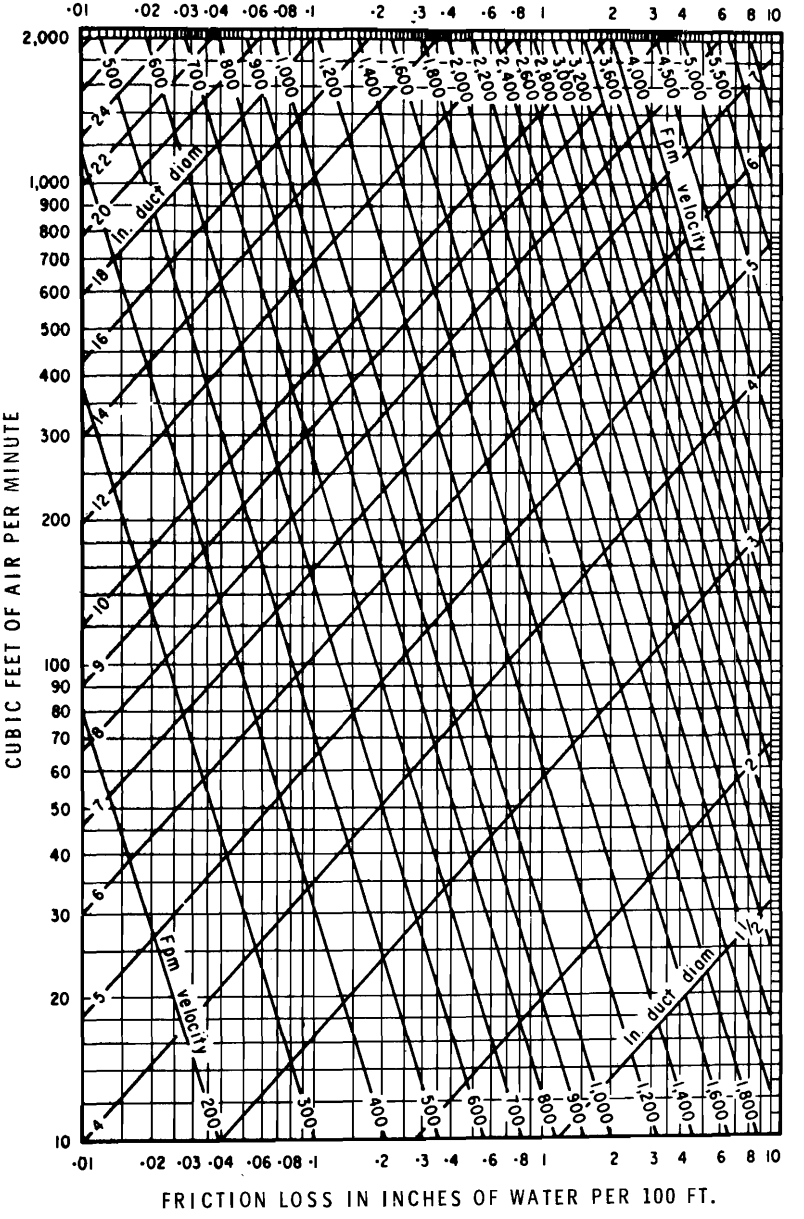


FIGURE 4-K
FRICTION OF AIR IN STRAIGHT DUCTS, 10 TO 2000 CU FT OF AIR PER MINUTE

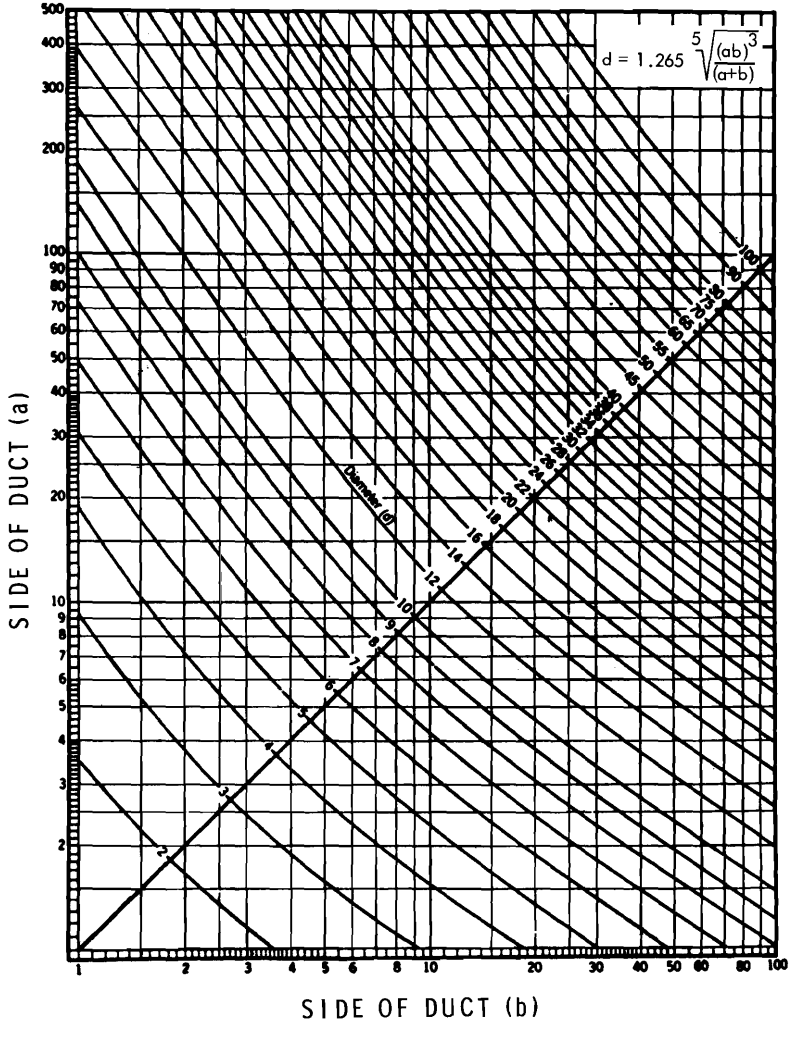


FIGURE 5-K
RECTANGULAR DUCT CONVERSION CHART (TO ROUND EQUIVALENT)

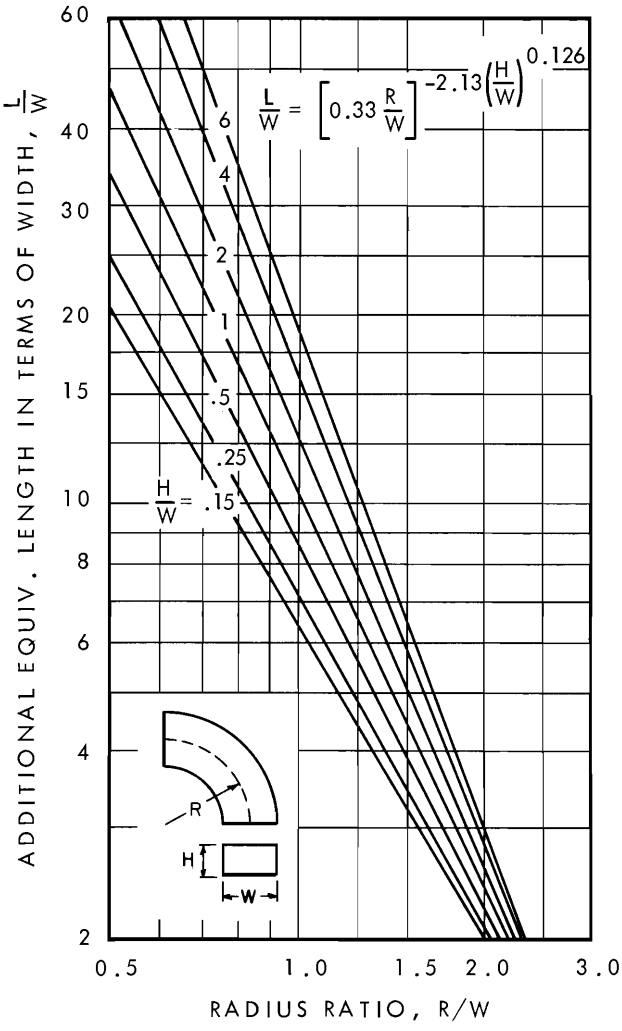


FIGURE 6-K
LOSS IN 90-DEG ELBOWS OF RECTANGULAR CROSS-SECTION

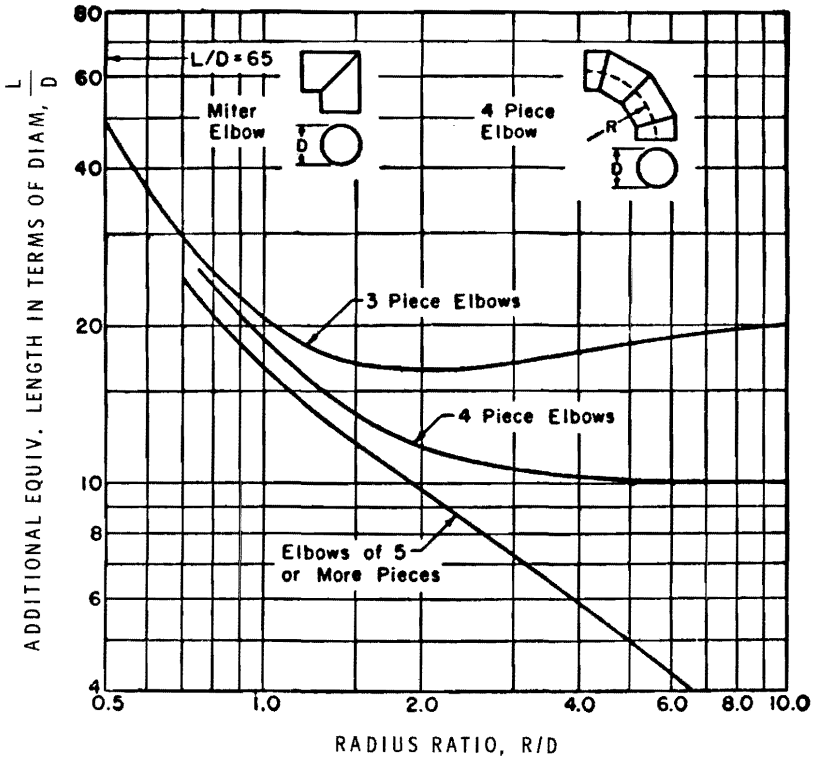


FIGURE 7-K
LOSS IN 90-DEG ELBOWS OF ROUND CROSS-SECTION

APPENDIX L

ELECTRICAL SERVICES

TABLE L-I AWG SIZES FOR COPPER CONDUCTORS, 230-240 VOLTS, SINGLE PHASE, 2 PER CENT VOLTAGE DROP

Load, Amp.	Minimum Allowable Size of Conductor			Length of Run, ft													
	In Cable, Conduit, Earth		Overhead in Air*	Compare size shown below with size shown to left of double line and select larger size													
	Types R-60, RW-60, T, TW, TWU, RWU	Types R-75, RW-75, TWH	Bare or Covered Conductors	50	75	100	125	150	175	200	225	250	275	300	350	400	450	500
5	14	14	10	14	14	14	14	14	12	12	12	12	10	10	10	10	8	8
7	14	14	10	14	14	14	14	12	12	12	10	10	10	10	8	8	8	8
10	14	14	10	14	14	12	12	10	10	10	10	8	8	8	8	6	6	6
15	14	14	10	14	12	12	10	10	8	8	8	8	6	6	6	4	4	4
20	12	12	10	12	12	10	8	8	8	6	6	6	6	4	4	4	4	2
25	10	10	10	10	10	8	8	6	6	6	6	4	4	4	4	3	2	2
30	10	10	10	10	10	8	6	6	6	6	4	4	4	4	3	2	2	2
35	8	8	10	10	8	8	6	6	4	4	4	4	3	3	2	2	1	1
40	8	8	10	10	8	6	6	4	4	4	4	3	3	2	2	1	1	0
45	6	8	10	10	8	6	6	4	4	4	3	3	2	2	1	1	0	0
50	6	6	10	8	8	6	4	4	4	3	3	2	2	2	1	0	0	00
60	4	6	8	8	6	4	4	4	3	2	2	1	1	1	0	00	00	00
70	4	4	8	8	6	4	4	3	2	2	1	1	0	0	00	00	00	000
80	2	4	6	6	6	4	3	2	2	1	1	0	0	00	00	000	000	4/0
90	2	3	6	6	4	4	3	2	1	1	0	0	00	00	000	000	4/0	4/0
100	1	3	6	6	4	3	2	2	1	0	0	00	00	000	000	4/0	4/0	250
115	0	2	4	6	4	2	2	1	0	00	00	00	000	000	4/0	250	250	250
130	00	1	4	4	3	2	1	0	0	00	000	000	000	4/0	4/0	250	300	300
150	000	0	2	4	2	1	0	0	00	00	000	4/0	4/0	4/0	250	300	300	350
175	4/0	00	2	2	2	1	0	00	000	000	4/0	4/0	250	300	300	350	350	400
200	250	000	1	1	1	00	00	00	000	4/0	4/0	250	300	300	350	400	400	500
225	300	4/0	0	0	0	0	00	000	4/0	4/0	250	300	300	350	400	500	500	500
250	350	250	00	00	00	00	000	000	4/0	250	300	300	350	350	400	500	500	600
275	400	300	00	00	00	00	000	4/0	250	300	300	350	350	400	500	500	600	600
300	500	350	000	000	000	000	4/0	4/0	250	300	350	350	400	500	500	600	600	700
325	600	400	4/0	4/0	4/0	4/0	4/0	250	300	300	350	400	500	500	500	600	700	700
350	600	500	4/0	4/0	4/0	4/0	4/0	250	300	350	400	400	500	500	600	600	700	750
375	700	500	250	250	250	250	250	300	350	350	400	500	500	500	600	700	750	
400	750	600	250	250	250	250	250	300	350	400	500	500	500	600	600	700		

Note to Table L-I:

* Conductors in overhead spans must be at least No. 10 for spans up to 50 ft and No. 8 for longer spans.

TABLE L-II AWG SIZES FOR ALUMINUM CONDUCTORS, 230-240 VOLTS, SINGLE PHASE, 2 PER CENT VOLTAGE DROP

Load, Amp.	Minimum Allowable Size of Conductor				Length of Run, ft													
	In Cable, Conduit, Earth		Overhead in Air*		Compare size shown below with size shown to left of double line and select larger size													
	Types R-60, RW-60, T, TW, TWU, RWU	Types R-75, RW-75, TWH	Bare or Covered Conductors		50	75	100	125	150	175	200	225	250	275	300	350	400	450	500
			Single	Triplex														
5	12	12	10		12	12	12	12	12	10	10	10	10	8	8	8	8	8	6
7	12	12	10		12	12	12	12	10	10	10	8	8	8	8	6	6	6	6
10	12	12	10		12	12	10	10	8	8	8	8	6	6	6	6	4	4	4
15	12	12	10		12	10	8	8	8	6	6	6	4	4	4	4	2	2	2
20	10	10	10		10	8	8	6	6	6	4	4	4	4	2	2	2	2	1
25	10	10	10		10	8	6	6	4	4	4	4	2	2	2	2	1	1	0
30	8	8	10		8	8	6	4	4	4	2	2	2	2	2	1	0	0	00
35	6	8	10		8	6	6	4	4	2	2	2	2	1	1	0	0	00	00
40	6	8	10		8	6	4	4	2	2	2	2	1	1	0	0	00	00	000
45	4	6	10		8	6	4	4	2	2	2	1	1	0	0	00	00	000	000
50	4	6	8		6	4	4	2	2	2	1	1	0	0	00	00	000	000	4/0
60	2	4	6	6	6	4	2	2	2	1	0	0	00	00	00	000	4/0	4/0	250
70	2	2(a)	6	4	6	4	2	2	1	0	0	00	00	000	000	4/0	250	250	300
80	1	2(a)	6	4	4	2	2	1	0	0	00	00	000	000	4/0	4/0	250	300	300
90	0	2(a)	4	2	4	2	2	1	0	00	00	000	000	4/0	4/0	250	300	300	350
100	0	1(a)	4	2	4	2	1	0	00	00	000	000	4/0	4/0	250	300	300	350	400
115	00	0(a)	2	1	2	2	0	0	00	000	000	4/0	4/0	250	250	300	350	400	500
130	000	00(a)	2	0	2	1	0	00	000	000	4/0	250	250	300	300	350	400	500	500
150	4/0	000(a)	1	00	1	1	00	000	000	4/0	250	250	300	300	350	400	500	500	600
175	300	4/0(a)	0	000	0	0	00	000	4/0	250	300	300	350	400	400	500	600	600	700
200	350	250	00	4/0	00	00	000	4/0	250	300	300	350	400	400	500	600	600	700	750
225	400	300	000		000	000	000	4/0	250	300	350	400	500	500	500	600	700	750	900
250	500	350	000		000	000	4/0	250	300	350	400	500	500	500	600	700	750	900	1M
275	600	500	4/0		4/0	4/0	4/0	300	350	400	400	500	500	600	600	700	800	900	1M
300	700	500	250		250	250	250	300	350	400	500	500	600	600	700	800	900	1M	
325	800	600	300		300	300	300	300	400	500	500	600	600	700	750	900	900		
350	900	700	300		300	300	300	350	400	500	600	600	700	750	800	900	1M		
375	1M	700	350		350	350	350	350	500	500	600	700	700	750	900	1M			
400		900	350		350	350	350	400	500	600	600	700	750	800	900				

Note to Table L-II:

* Conductors in overhead spans must be at least No. 10 for spans up to 50 ft and No. 8 for longer spans

TABLE L-III AWG SIZES FOR COPPER CONDUCTORS, 115-120 VOLTS, SINGLE PHASE, 2 PER CENT VOLTAGE DROP

Load, Amp.	Minimum Allowable Size of Conductor			Length of Run, ft										
	In Cable, Conduit, Earth		Overhead in Air*	Compare size shown below with size shown to left of double line and select larger size										
	Types R-60, RW-60, T, TW, TWU, RWU	Types R-75, RW-75, TWH	Bare and Covered Conductors	30	40	50	75	100	125	150	175	200	225	250
5	14	14	10	14	14	14	14	12	12	10	10	10	8	8
7	14	14	10	14	14	14	12	12	10	10	8	8	8	8
10	14	14	10	14	14	12	12	10	8	8	8	6	6	6
15	14	14	10	14	12	12	10	8	6	6	6	6	4	4
20	12	12	10	12	10	10	8	6	6	6	4	4	4	3
25	10	10	10	10	8	8	8	6	4	4	4	3	3	2
30	10	10	10	10	8	8	6	4	4	4	3	2	2	2
35	8	8	10	10	8	8	6	4	4	3	2	2	1	1
40	8	8	10	8	8	6	6	4	3	2	2	1	1	0
45	6	8	10	8	8	6	4	4	3	2	1	1	0	0
50	6	6	10	8	6	6	4	3	2	2	1	0	0	00
60	4	6	8	8	6	4	4	2	1	1	0	0	00	00
70	4	4	8	6	6	4	3	2	1	0	00	00	000	000
80	2	4	6	6	4	4	2	1	0	0	00	000	000	4/0
90	2	3	6	6	4	4	2	1	0	00	000	000	4/0	4/0
100	1	3	6	6	4	3	2	0	00	00	000	4/0	4/0	250
115	0	2	4	4	4	2	1	0	00	000	4/0	4/0	250	250
130	00	1	4	4	2	2	0	00	000	4/0	4/0	250	300	300
150	000	0	2	2	2	1	0	00	4/0	4/0	250	300	300	350
175	4/0	00	2	2	2	1	00	000	4/0	250	300	350	350	400
200	250	000	1	1	1	0	00	4/0	250	300	350	350	400	500

Note to Table L-III:

* Conductors in overhead spans must be at least No. 10 for spans up to 50 ft and No. 8 for longer spans.

TABLE L-IV AWG SIZES FOR COPPER CONDUCTORS, SINGLE-PHASE MOTORS, 115-230 VOLT, 2 PER CENT VOLTAGE DROP

Motor Hp	Rated Volts	Full Load, Amp.	Minimum Allowable Size of Conductor			Length of Run, ft									
			In Cable, Conduit, Earth		Overhead in Air*	Compare size shown below with size shown to left of double line and select larger size									
			Types R-60, RW-60 T, TW, TWU, RWU	Types R-75, RW-75, TWH	Bare & Covered Conductors	50	75	100	150	200	250	300	350	400	500
1/6	115	4.4	14	14	10	14	14	12	10	10	8	8	8	6	6
1/4	115	5.8	14	14	10	14	14	12	10	10	8	8	6	6	6
1/3	115	7.2	14	14	10	14	12	12	10	8	8	6	6	6	4
1/2	115	9.8	14	14	10	14	12	10	8	6	6	4	4	4	3
3/4	115	13.8	12	12	10	12	10	8	6	6	4	4	3	3	2
1/6	230	2.2	14	14	10	14	14	14	14	14	12	12	12	10	10
1/4	230	2.9	14	14	10	14	14	14	14	14	12	12	12	10	10
1/3	230	3.6	14	14	10	14	14	14	14	12	12	10	10	10	10
1/2	230	4.9	14	14	10	14	14	14	14	12	12	10	10	10	8
3/4	230	6.9	14	14	10	14	14	14	12	12	10	10	10	8	8
1	230	8	14	14	10	14	14	14	12	10	10	10	8	8	6
1½	230	10	14	14	10	14	14	12	10	10	8	8	8	6	6
2	230	12	12	12	10	12	12	12	10	10	8	8	6	6	6
3	230	17	10	10	10	10	10	10	8	8	6	6	6	4	4
5	230	28	8	8	10	10	10	8	6	6	4	4	3	2	2
7½	230	40	6	6	10	10	8	6	4	4	3	2	2	1	0
10	230	50	4	6	8	8	8	6	4	3	2	2	1	0	00

Note to Table L-IV:

* Conductors in overhead spans must be at least No. 10 for spans up to 50 ft and No. 8 for longer spans.

TABLE L-V AWG SIZES FOR COPPER CONDUCTORS, THREE-PHASE MOTORS, 208 VOLTS, 2 PER CENT VOLTAGE DROP

Motor Hp	Full Load, Amp.	Minimum Allowable Size of Conductor			Length of Run, ft						
		In Cable, Conduit, Earth		Overhead in Air*	Compare size shown below with size shown to left of double line and select larger size						
		Types R-60, RW-60, T, TW, TWU, RWU	Types R-75, RW-75, TWH	Bare & Covered Conductors	75	100	150	200	300	400	500
½	2.0	14	14	10	14	14	14	14	14	14	12
¾	2.8	14	14	10	14	14	14	14	14	12	12
1	3.5	14	14	10	14	14	14	14	12	12	10
1½	5.0	14	14	10	14	14	14	12	12	10	8
2	6.5	14	14	10	14	14	12	12	10	8	8
3	9	14	14	10	14	14	12	10	8	8	6
5	15	12	12	10	12	12	10	8	6	6	4
7½	22	10	10	10	10	10	8	6	4	4	3
10	27	8	8	10	10	8	6	6	4	3	2
15	40	6	6	10	8	6	6	4	3	1	0
20	52	4	6	8	8	6	4	3	2	0	00
25	64	2	4	6	6	4	4	2	1	00	000
30	78	1	3	6	4	4	3	1	0	000	4/0

Note to Table L-V:

* Conductors in overhead spans must be at least No. 10 for spans up to 50 ft and No. 8 for longer spans.

TABLE L-VI MINIMUM SIZE OF GROUNDING CONDUCTOR

Current-Carrying Capacity of Largest Service Conductor or Equivalent for Multiple Conductors Amp.	Size of Copper Grounding Conductor, AWG
100 or less	8
101 to 125	6
126 to 165	4
166 to 260	2
261 to 355	0
356 to 475	00
Over 475	000

TABLE L-VII CABLE SPACING FOR HEATING FLOOR SLABS

Watt Density, watts per sq ft	Watts Per Lineal Foot of Heating Cable															
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	(Spacing Between Adjacent Runs of Cable, In.)															
10	6	7¼	8⅜	9⅝	10¾	12	–	–	–	–	–	–	–	–	–	–
15	4	4⅞	5⅝	6⅜	7¼	8	8¾	9⅝	10⅜	11¼	12	–	–	–	–	–
20	3	3⅝	4¼	4¾	5⅜	6	6⅝	7¼	7¾	8⅜	9	9⅝	10¼	10¾	11⅜	12
25	2⅜	2⅞	3⅜	3⅞	4⅜	4¾	5¼	5¾	6⅛	6¾	7¼	7¾	8⅛	8⅝	9⅛	9⅝
30	2	2⅜	2¾	3¼	3⅝	4	4⅜	4¾	5¼	5⅝	6	6⅜	6¾	7¼	7¼	8
35	1¾	2	2⅜	2¾	3	3⅜	3¾	4⅛	4½	4¾	5⅛	5½	5⅞	6¼	6½	6⅞
40	1½	1¾	2	2⅜	2¾	3⅛	3¼	3⅝	3⅞	4¼	4½	4¾	5⅛	5⅜	5¾	6

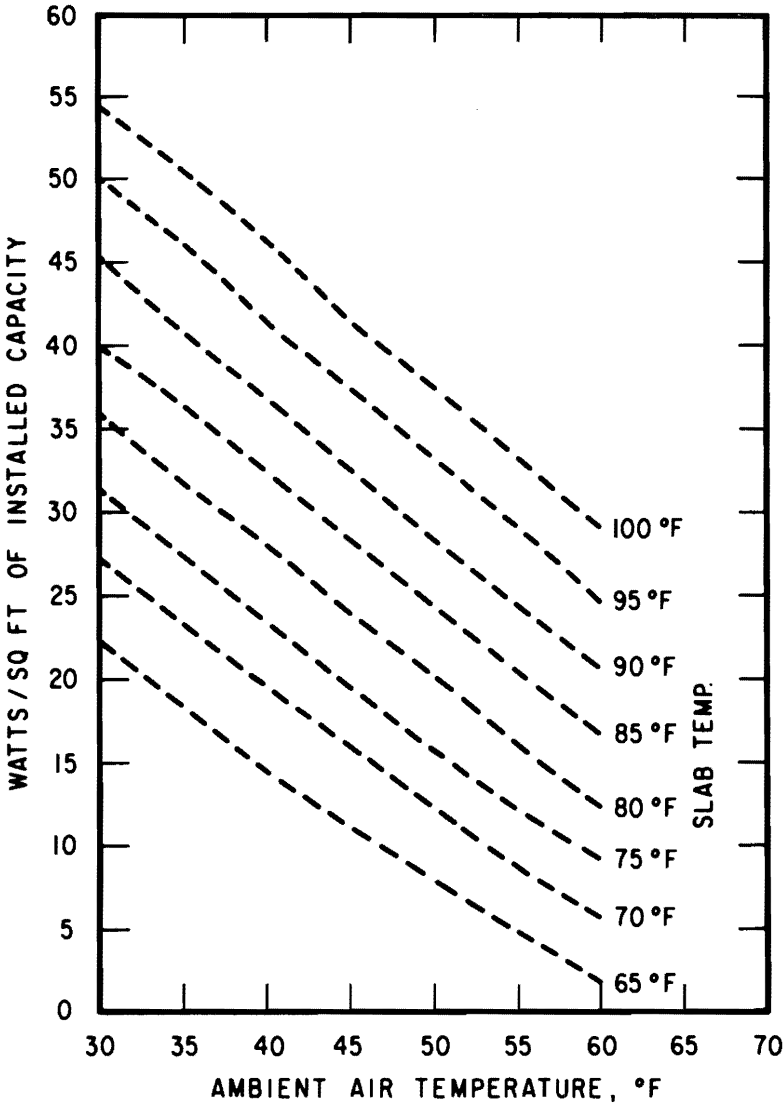


FIGURE 1-L

APPROXIMATE SLAB TEMPERATURES OBTAINED WITH VARIOUS WATT DENSITIES AND AMBIENT AIR TEMPERATURES

APPENDIX M

CLADDING

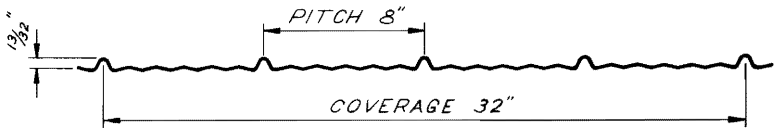


FIGURE I-M
PROFILE NO. 1

TABLE M-I SAFE LOADS (PSF)
TABLE FOR EXTERIOR METAL CLADDING

Span, in.**	Thickness of Steel Sheet* Commercial Quality			Thickness of Aluminum Utility Sheet		
	26 ga. 0.0179	28 ga. 0.0149	30 ga. 0.0120	0.025	0.020	0.018
10	146	121	100	144	117	105
12	102	84	69	100	80	73
14	75	62	51	73	59	54
16	57	47	39	56	45	41
18	45	37	31	44	36	32
20	37	30	25	36	29	26
22	30	25	21	30	24	22
24	25	21	17	24	20	18

Notes to Table M-I:

* Thickness indicates core thickness in inches. When the sheet is galvanized, for 1¼ oz. commercial quality galvanized coating, add 0.0038 to the core thickness. For 1½ oz., add 0.0044. For 2 oz., add 0.0060.

** Loading tables are based on continuous loading over 4 or more spans in pounds per square foot.

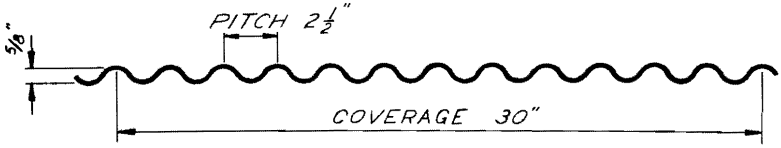


FIGURE 2-M
PROFILE NO. 2

TABLE M-II SAFE LOADS (PSF)
TABLE FOR EXTERIOR METAL CLADDING

Span, in.**	Thickness of Steel Sheet* Commercial Quality			Thickness of Aluminum Utility Sheet		
	26 ga. 0.0179	28ga. 0.0149	30 ga. 0.0120	0.025	0.020	0.018
24	164	137	110	121	94	83
30	105	80	71	78	60	57
36	73	61	50	54	42	39
42	53	44	36	40	31	29
48	41	34	28	30	25	22
54	32	27	22	24	19	18

Notes to Table M-II:

* Thickness indicates core thickness in inches. When the sheet is galvanized, for 1¼ oz. commercial quality galvanized coating add 0.0038 to the core thickness. For 1½ oz., add 0.0044. For 2 oz., add 0.0060.

** Loading tables are based on continuous loading over 3 or more spans in pounds per square foot.

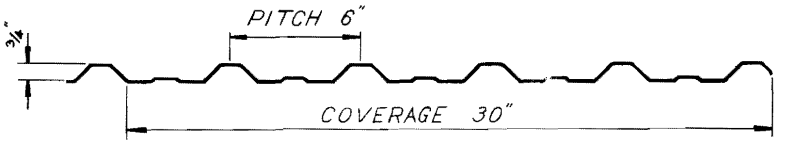


FIGURE 3-M

PROFILE NO. 3

TABLE M-III SAFE LOADS (PSF)
TABLE FOR EXTERIOR METAL CLADDING

Span, in.**	Thickness of Steel Sheet* Commercial Quality			Thickness of Aluminum Utility Sheet		
	24 ga. 0.0239	26 ga. 0.0179	28 ga. 0.0149	0.040	0.032	0.025
36	103	76	58	83	64	50
42	75	56	43	61	48	38
48	58	43	33	46	36	29
54	45	34	26	36	29	23
60	36	27	21	30	23	18
66	30	23	17	25	19	15
72	25	19	15	21	16	13

Notes to Table M-III:

* Thickness indicates core thickness in inches. When the sheet is galvanized, for 1¼ oz. commercial quality galvanized coating add 0.0038 to the core thickness. For 1½ oz., add 0.0044. For 2 oz., add 0.0060.

** Loading tables are based on continuous loading over 3 or more spans in pounds per square foot.

TABLE M-IV GRADES AND USES OF PLYWOOD

Grade	Description	Sizes	Uses
Good Two Sides (G2S)	Each face smooth and sound, no knots or open defects, may contain neatly made patches, suitable for highest grade paint or other finish. Waterproof glue.	Usually supplied in panels 48 in. by 96 in. and in thicknesses of 1/4 in., 3/8 in. 1/2 in., 5/8 in. and 3/4 in. Also may be manufactured within the following limits: Width: Up to 60 in. Length: Up to 120 in. (over 120 in. with scarf joints). Thicknesses: 3/16 in. up to 1¼ in.	Where appearance is the prime consideration, with both sides of panel exposed to view, e.g., furniture, booth partitions, cabinet doors, etc.
Good one side solid back (G/Solid)	Face smooth and sound, no knots or open defects, may contain neatly made patches. Back a firm solid paintable surface with neatly made patches, and small sound knots. Waterproof glue.		Where best appearing surface is required on one side with relatively good appearance on the other. e.g., doors, furniture, built-in fitments, kitchen cabinets, toys, etc.
Good one side (G1S)	Face smooth and sound, no knots, or open defects, may contain neatly made patches. Back may have limited size knot holes or other defects which have no material effect on strength or serviceability. Waterproof glue.		Where good appearance of one side only is a prime consideration, e.g., panelling, soffits, sliding doors. etc.
Solid Two Sides (Solid 2 S)	Each face solid, contains neatly made patches and small sound knots. Similar to back of G/Solid Grade. Waterproof Glue.		Same uses as Good Two Sides when finishing requirements are not as exacting, e.g., shelving, concrete forms. Recommended for opaque paint finishes.
Solid one side (Solid 1 S)	Face solid, contains neatly made patches, and small sound knots. Back may contain limited size knot holes and other defects which have no material effect on strength or serviceability. Waterproof glue.		Same uses as Good One Side when finishing requirements are not as exacting. e.g., floor underlay where sanded surface is desired. Suitable for concrete forms.
Marine	Both faces smooth and sound, no knots or open defects, may contain neatly made patches. All interior plies solid, with neatly made patches and small sound knots. Waterproof glue.		Hull planking and all marine uses.

TABLE M-IV GRADES AND USES OF PLYWOOD (Cont'd)

Grade	Description	Sizes	Uses
Concrete form 2 sides	Each face solid, contains neatly made patches, tight splits, small sound knots with reasonable amounts of rough or torn grain. Both faces sanded, edges sealed with green-coloured compound.	Supplied in panels 48 in. x 96 in. and in thicknesses of 5/8, 11/16, 3/4 in.	For concrete forms where a good, smooth surface is required and both plywood faces will be used for repetitive work.
Concrete form 1 side	Face solid, contains neatly made patches, tight splits, small sound knots, reasonable amount of rough or torn grain. Back may contain limited size knot holes and other defects which have no material effect on strength or serviceability. Both faces sanded, edges sealed with green-coloured compound.		For concrete forms where a good smooth surface is required and only one plywood face will be used for repetitive work.
Sheathing	Construction grade. Each face may have limited size open defects which have no material effect on strength or serviceability. Waterproof glue.	Usually supplied in panels, 48 in. by 96 in. and in thicknesses of 5/16 in., 3/4 in., 1/2 in., 3/8 in., and 1/4 in. Also may be manufactured within the following limits: Width: Up to 60 in. Length: Up to 120 in. (over 120 in. with scarf joints). Thicknesses: 5/16 to 1¼ in.	Where strength and economy are required but smooth finish unnecessary, e.g., structural applications, such as roofing, wall sheathing, subflooring and single finish for term structures, fences, utility and industrial buildings.
Select Sheathing	One face has no open defects except for limited number of splits, otherwise similar to sheathing grade.		For uses where sanded material is not required, e.g., fences and for underlay with tile, linoleum or other flooring which does not require a sanded underlay.
High density Overlay	Resin-impregnated cellulose fibre sheet is bonded to plywood surface. Overlay is translucent, hard and smooth. Further finishing not required. Bond between overlay and plywood is equal to waterproof glue line between veneers.	Supplied in panels 48 in. by 96 in. and in thicknesses of 5/16 in., 3/4 in., 1/2 in., 3/8 in. and 1/4 in.	Excellent where hard finish is required, e.g. worktables, school furniture, lockers, bins, containers, tanks, signs, displays, and fixtures. Ideal for cold atmosphere storage lining and concrete forms.
Medium Density Overlay	Resin-impregnated cellulose fibre overlay sheet is basically opaque although underlying grain may appear. Hard, smooth, suitable for painting. Bond between overlay and plywood is equal to waterproof glue line between veneers.		Used for siding, soffits, panelling, built-in fitments, cabinets, truck bodies, and any use requiring superior paint finish or frequent cleaning. Suitable for cold atmosphere storage lining.

TABLE M-V PLYWOOD WALL SHEATHING, CLADDING AND INTERIOR FINISH

Recommended application of fir plywood wall sheathing, cladding, and interior finish for farm structures.				
Plywood Thickness, in.	Support Spacing, in.		Nail Size, in.	Nail Spacing
	Face Grain Perpendicular To Supports	Face Grain Parallel To Supports		
5/16	24	16*	2	6 in. apart along panel edges, 12 in. apart on intermediate supports.
3/8	32	24		
1/2	48	32	2	6 in. apart along panel edges, 6 in. apart along intermediate supports.
3/8	Structural Grid System – plywood fastened to supports forming a 48 in. by 48 in. grid system (i.e. vertical studs and horizontal blocking at 48 in. o.c.)			

Notes to Table M-V:

1. The plywood thicknesses shown are for Douglas fir plywood. Where other species are used appropriate increases in thicknesses should be considered.
2. For applications of combined sheathing and cladding all edges must be supported to prevent differential deflection; e.g. battens, blocking, T & G or overlapping. Where separate cladding is used the sheathing does not require support between main members.
3. Special consideration must be given to the selection of plywood thickness and to the nailing schedule if the structure is designed to withstand storage pressure, in which case the Load/Span Graphs should be used.
4. All panels should be separated by a 1/16 in. gap.

* If used as sheathing under cladding or as interior lining support spacing may be 24 in.

TABLE M-VI PLYWOOD ROOF SHEATHING

Framing		Plywood Thickness, in.					Remarks
		5/16	3/8	1/2	5/8	3/4	
Spacing of Supports, in.	Panel edges supported by 2 x 4 headers fitted between rafters or other framing members.	24	32	48	54	60	
	Panel edges supported to prevent differential deflection; H-clips, T & G plywood, Spline, etc.	16	24	32	48	54	H-clip spacing shall be: 1 at midpoint for supports up to 24 in. o.c. 2 at ⅓ points for supports 25 in. to 48 in. o.c. 3 at ¼ points for supports 49 in. to 72 in. o.c.
	Panel edges not supported.	12	16	24	32	48	
Nail Length, in.	Common or spiral nails	1½	1½	1¾	2	2¼	Panels should be fastened to supports by nails spaced at intervals not exceeding 6 in. along all edges supported on framing nor 12 in. along intermediate supports, except that when primary supports are spaced 36 in. or greater on centres nails should be spaced at intervals not exceeding 6 in. along all supports.
	Annularly grooved nails	1½	1½	1½	1¾	2	
Staple Length, in.		⅞	1⅛	1½	2	–	Staples should be non-divergent, narrow crown, 18 gauge steel wire, galvanized, or equal. Spacing should be 3 in. along all edges supported on framing members and 6 in. along intermediate supports.

Notes to Table M-VI:

1. The plywood thicknesses shown are for Douglas fir plywood. Where other species are used appropriate increases in thicknesses should be considered.
2. All panels should be separated by 1/16-in. gap.
3. When panel edges are unsupported, consideration must be given to the effect of differential deflection between panel edges on the roofing material. Concentrated loads such as those imposed by foot traffic are the most critical.

TABLE M-VII MINIMUM TEST REQUIREMENTS FOR COATED FINISH ON METALS

Qualification Test	Method	Minimum Requirement
Dry Film Thickness	For Aluminum: ASTM D-1005-51 (1966) For Steel: ASTM D-1186-53 (1968)	0.8 mil (0.0008 in.)
Film Hardness	Pencil Hardness Test	A flat round Eagle turquoise lead pencil at a 45° angle to the paint film shall not dig into the surface of the material when using a pencil hardness of "F" minimum.
Humidity Resistance	For Aluminum: ASTM D-1735-62 (1968) For Steel: ASTM D-2247-68	May show only slight softening and only a few scattered blisters no larger than No. 8 (ASTM D-714-56 (1965) when exposed for 1000 hours in 100% relative humidity at 100°F (37.8°C).
Salt Spray Resistance	ASTM B-117-64	After 750 hours exposure in 5% salt solution no more than 1/16 in. under film corrosion or creepage from scribe lines and no blistering.
Accelerated Weathering Resistance	ASTM D-822-60 (1968)	After exposure for 1000 hrs. the coating shall exhibit no cracking, checking, loss of adhesion or spotting (except normal water spotting), and may show slight colour fading and only slight chalking. ASTM D-659-44 (1965).
Adhesion	Standard Cross Hatch Adhesion Test	No failure
Adhesion at Bends	No visible cracking when viewed without instruments at a distance of 15 in.	
Shock Resistance	Shall show no deterioration in a button forming test in accordance with the following: By means of a falling weight impact tester using a 2-lb. weight conducted on the reverse side of the panel with: For aluminum – an impact equivalent to 30-in.-lb with a 5/8-in. diam. ball conducted on a sheet 0.032 in. thick or heavier, or For steel – an impact equivalent to 75-in.-lb with a 5/8-in. diam. ball conducted on a sheet 0.021 in. thick or heavier. At plus 70°F, no loss of adhesion shall be exhibited when tested by means of No. 600 Scotch cellophane tape. At minus 10°F, any crack that may develop shall not be greater than 1/32 in.	

TABLE M-VII (Cont'd)

Qualification Test	Method	Minimum Requirement
Water Imersion	ASTM D-870-54 (1968)	Shall be conducted for 100 hours in distilled water at 70°F ± 2°F. Four (4) hours after removal from the water, there shall be no softening and no appreciable change in colour as observed in the MacBeth Daylight booth.
Oil Imersion	ASTM D-870-54 (1968) (Using SAE grade 10 oil)	Shall be conducted for 48 hours at 70°F ± 2°. Twenty-four (24) hours after removal from the oil, there shall be no softening and no appreciable change in colour as observed in the MacBeth Daylight booth.

TABLE M-VIII
EXTERIOR PARTICLEBOARD WALL SHEATHING, CLADDING AND INTERIOR FINISH

Particleboard Thickness	Support Spacing		Nail		Staple	
	Sheathing	Cladding	Size	Spacing	Size	Spacing
5/16 in.	24 in.	continuous	2 in.	6 in. o.c. along panel edges 12 in. o.c. along intermediate supports. (6/12)	1-½ in.	4/8
3/8 in.	32 in.	16 in.	2 in.	6/12	1-½ in.	4/8
½ in.	48 in.	24 in.	2 in.	6/6	2 in.	4/4
3/8 in.	Particleboard fastened to supports 48 in. o.c. each way		2 in.	6/6	2 in.	4/4

Notes to Table M-VIII:

1. For combined sheathing and cladding applications all particleboard edges must be supported to prevent differential deflection, e.g. battens, blocking, T & G or overlapping. Where separate cladding is used, sheathing edges between main members require no support.
2. Special consideration must be given to particleboard thickness and fastening if the structure is designed to withstand storage pressures, e.g., granaries.
3. All panels should be separated by a 1/8-in. gap.

TABLE M-IX
EXTERIOR PARTICLEBOARD ROOF SHEATHING

	Framing	Particleboard Thickness, in.					Remarks
		3/8	7/16	1/2	5/8	3/4	
Spacing of Supports, in.	Panel edges supported by 2 x 4 headers fitted between rafters or other framing members	24	32	40	48	54	
	Panel edges supported to prevent differential deflection using H-clips.	16	24	32	40	48	H-clip spacing should be: 1. at mid-point for supports up to 24 in. o.c. 2. at 1/3 points for supports 25 in. o.c. to 48 in. o.c.
	Panel edges unsupported	12	16	24	32	40	
Nail length, in.	Common nails	1½	1¾	1¾	2	2¼	Space nails 6 in. o.c. panel edges, 12 in. o.c. into intermediate supports except when support spacing is 36 in. o.c. or more space nails 8 in. o.c. into all supports.
	Annularly grooved nails	1½	1½	1½	1¾	2	
Staple length, in.		1 1/8	1½	1½	2	–	Spacing similar to nails.

Notes to Table M-IX:

1. All panels should be separated by a 1/8-in. gap.
2. When panel edges are unsupported, consideration must be given to the effect of differential deflection between panel edges on the roofing material. Concentrated loads such as those imposed by foot traffic are the most critical.

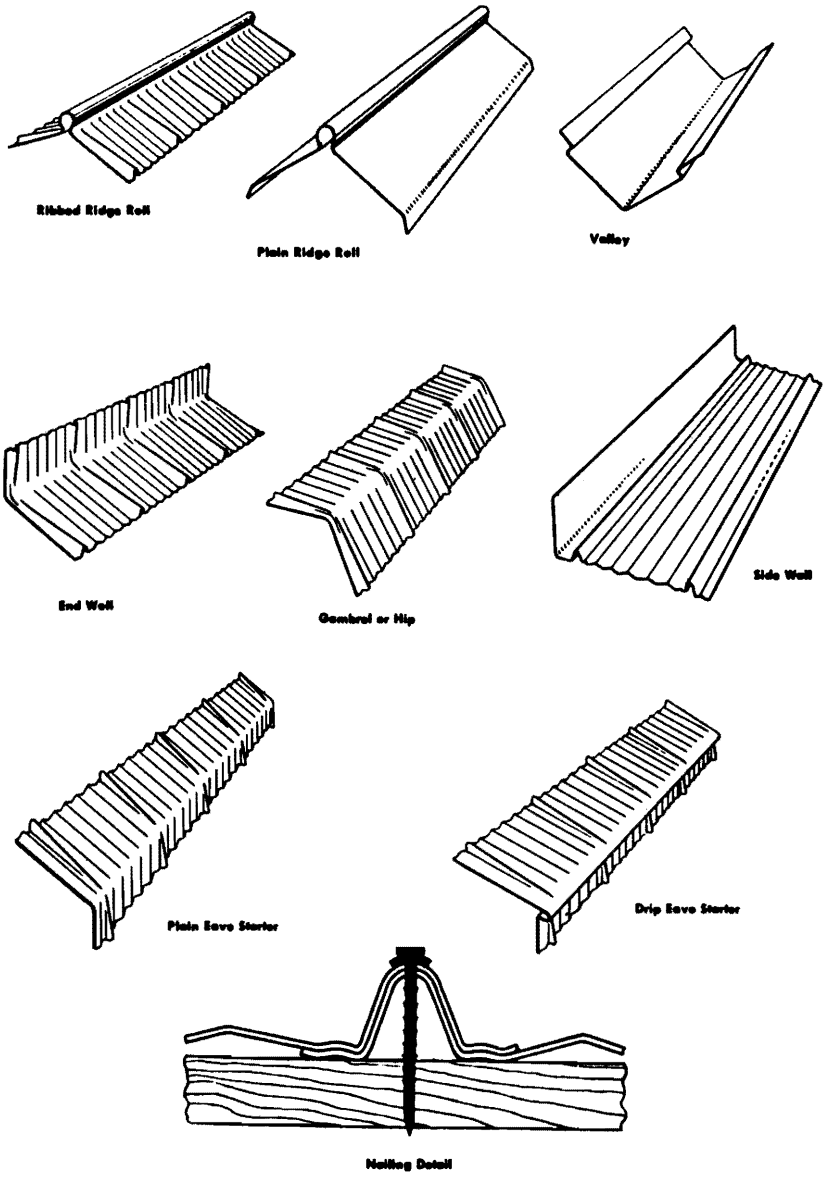


FIGURE 4-M
ACCESSORIES FOR ALUMINUM AND STEEL CLADDING

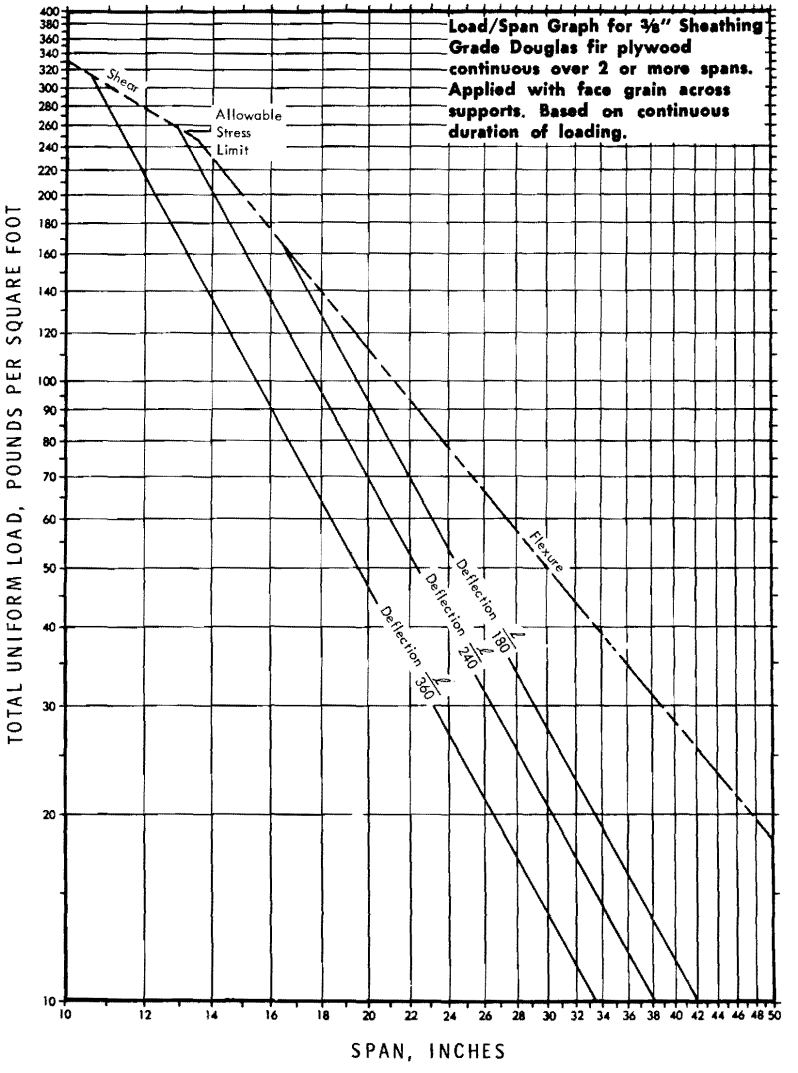


FIGURE 5-M

LOAD/SPAN GRAPH FOR 3/8-in. SHEATHING GRADE DOUGLAS FIR PLYWOOD

Notes to Figure 5-M:

The broken line marked "shear" and "flexure" indicates the load/span relationship at which the calculated shear or bending stress in the plywood reach the allowable stress as set forth in the Table of allowable unit stresses for Douglas Fir plywood in the Chapter on Wood in NBC Supplement No. 4, Canadian Structural Design Manual, 1970, adjusted for continuous duration of loading. Solid lines indicate the load/span relationships at which the indicated deflections are reached. In many farm building applications deflection is not critical so stress limitations will govern.

See the inset on Figure 6-M for instructions on the use of the graphs.

Load/span graphs Figures 5-M to 9-M are based upon Douglas fir plywood. Where other species are used appropriate increases in thickness or reductions in span should be considered.

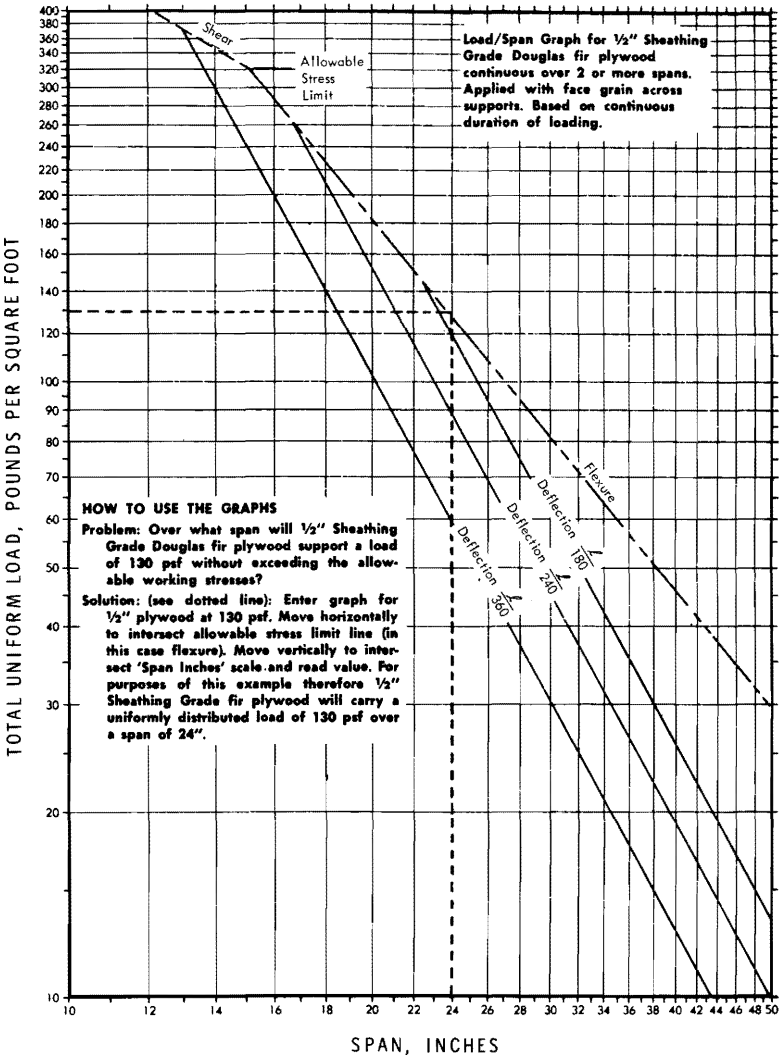


FIGURE 6-M

LOAD/SPAN GRAPH FOR 1/2-in. SHEATHING GRADE DOUGLAS FIR PLYWOOD

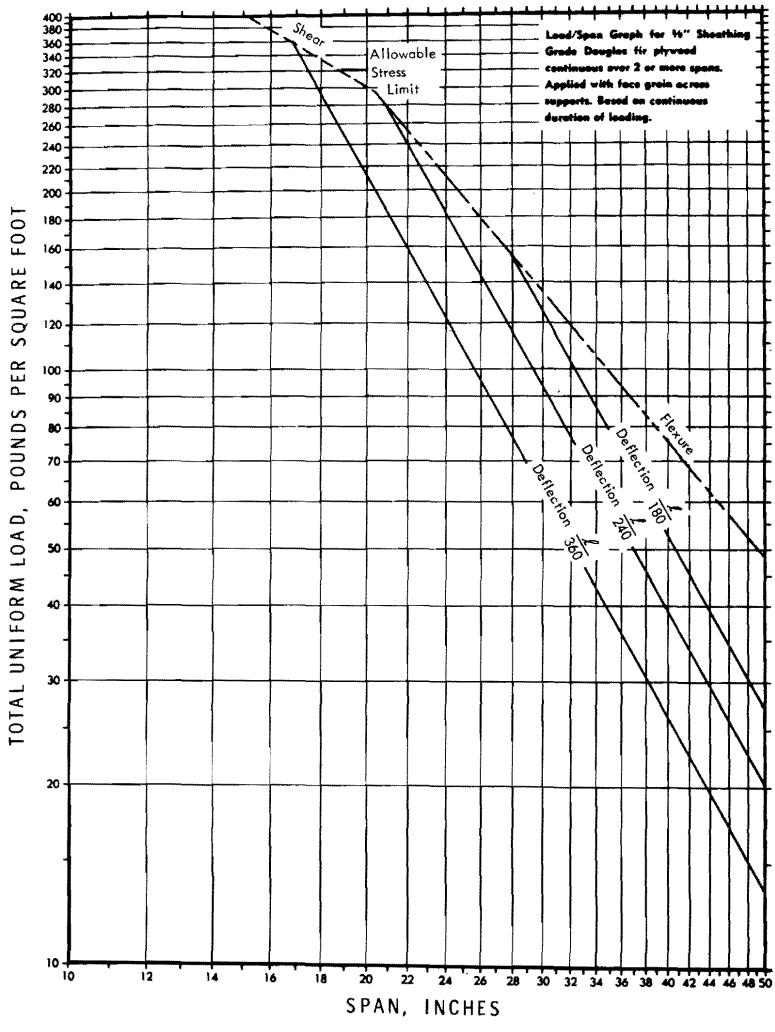


FIGURE 7-M

LOAD/SPAN GRAPH FOR 5/8-in. SHEATHING GRADE DOUGLAS FIR PLYWOOD

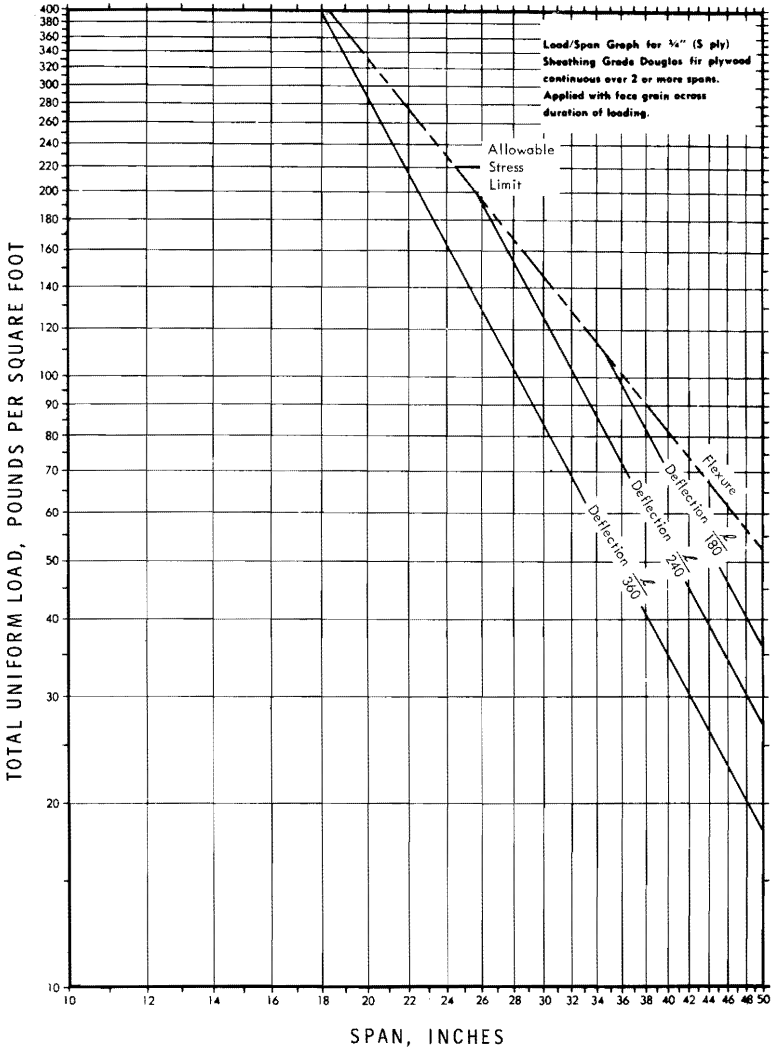


FIGURE 8-M

LOAD/SPAN GRAPH FOR 3/4-in. SHEATHING GRADE DOUGLAS FIR PLYWOOD

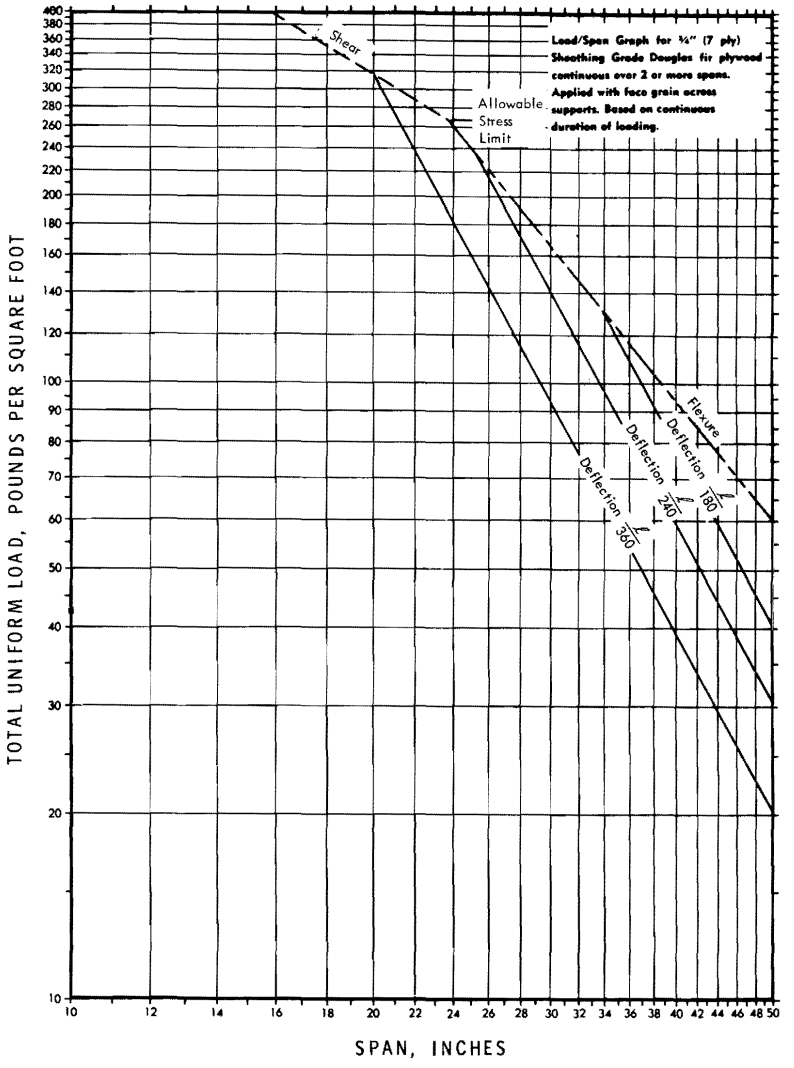


FIGURE 9-M

LOAD/SPAN GRAPH FOR 3/4-in.(7-PLY) SHEATHING GRADE DOUGLAS FIR PLYWOOD

APPENDIX N

INSULATION VALUES OF BUILDING MATERIALS

TABLE N-I INSULATION VALUE OF BUILDING MATERIALS

Material	Thickness, in.	*R Value (Resistance to heat flow, for thickness listed)	
		At 25°F	At 75°F
Insulations			
Mineral wool or glass fibre, blanket, batt or loose fill types			
0.65 lb/cu ft density	1	3.7	3.3
0.75 lb/cu ft density	1	3.7	3.4
1.00 lb/cu ft density	1	4.0	3.7
1.50 lb/cu ft density	1	4.2	4.0
Cellulose fiber (cotton, wood pulp etc.)	1		3.9
Expanded mica, "vermiculite", 4 to 6 lb/cu ft	1	2.5	2.3
Dry sawdust, or wood shavings, 0.8 to 1.5 lb/cu ft	1		2.2
Straw (cut, dry)	1		1.43
Corkboard	1		3.8
Polystyrene foam, 1.9 lb/cu ft	1	4.2	3.9
Polyurethane foam, 1.5 to 2.5 lb/cu ft	1	5.9	5.9
Building Boards and Papers			
Asbestos board	3/16		0.22
Fir plywood	3/8		0.47
Fiberboard	1/2		1.52
Phenolic bonded particleboard	3/8		0.49
Asphalt felt, 15 lb/100 sq ft			0.06
Polyethylene film vapour barrier	0.002 to 0.010		0.00
Frame Construction			
Wood sheathing and building paper	3/4		1.16
Same, add, lap siding			2.00
Lap siding or wood shingles			0.78
Solid wood sheathing, pine or fir	1		1.25
Roofing Materials			
Built-up bitumen and felt, gravel	1		0.75
Asphalt shingles			0.15
Concrete and Masonry			
Plain or reinforced concrete, 140 lb/cu ft	1		0.08
Lightweight concrete, 120 lb/cu ft	1		0.19
80	1		0.40
40	1		0.86
30	1		1.11
20	1		1.43
Concrete block, oval cores	8		1.11
Same, plus vermiculite fill	8		1.79
Lightweight block (expanded shale, clay, slate, slag or pumice)	8		2.00
Same plus expanded mica fill	8		4.00
Surface Resistances			
F_o, for outside wall, 14 mph wind			0.17
F_i, for inside wall (no wind)			0.61
Concrete floor to ground (at 20° temp. difference, air 6 in. above floor to ground)			10.0

TABLE N-I (Cont'd)

Material	Thickness, in.	*R Value (Resistance to heat flow, for thickness listed)	
		At 25°F	At 75°F
Air space resistances			
vertical air space, ¾ in. and larger			1.2
Windows (including resistances of air space and surfaces)			
One vertical glass sheet			0.88
Two vertical glass sheets, air space ½ in.			1.8
Two vertical glass sheets, air space 1 in. or greater			1.89

Notes to Table N-I:

* Resistance values are from 1957 ASHRAE Handbook of Fundamentals, Chapter 26 and other sources. R = I/C, where C = thermal conductivity, Btu/(hr) (sq ft) (°F), for thickness listed.

TABLE N-II TYPICAL FLOOR PERIMETER HEAT LOSS FACTORS*

Description of Floor Perimeter	Perimeter Heat Loss Factor (F)
Normal concrete, not insulated	0.82
Normal concrete, insulated near the exterior face to 12 in. below exterior grade with rigid insulation having R = 4 (see Table N-I)	0.49
Normal concrete insulated near the exterior face to 12 in. below exterior grade with rigid insulation having R = 8 (see Table N-I)	0.25

Note to Table N-II:

* To estimate perimeter heat losses from concrete floors on grade, use the following formula:

$H = PF(T_i - T_o)$

where H = Heat loss, Btu/hr

P = Floor perimeter, ft

F = Floor perimeter heat loss factor (see Table N-II)

T_i = Inside air temperature, °F

T_o = Outside air temperature, °F

APPENDIX O

DIMENSIONS OF FREE STALLS

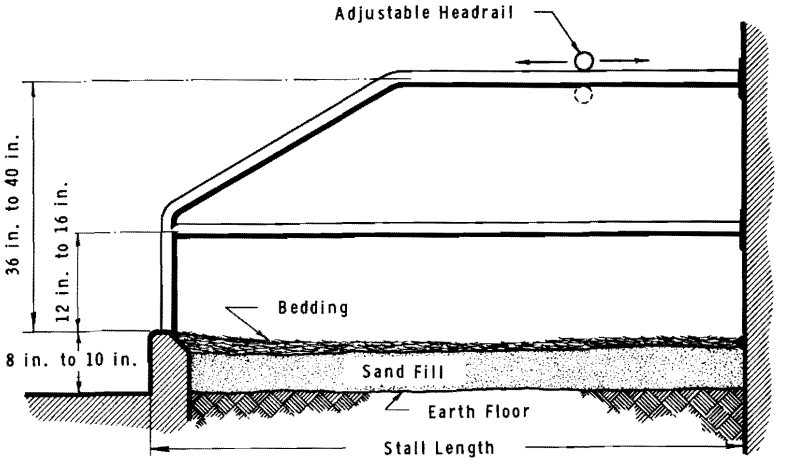


FIGURE 1-O
FREE STALL WITH EARTH FLOOR

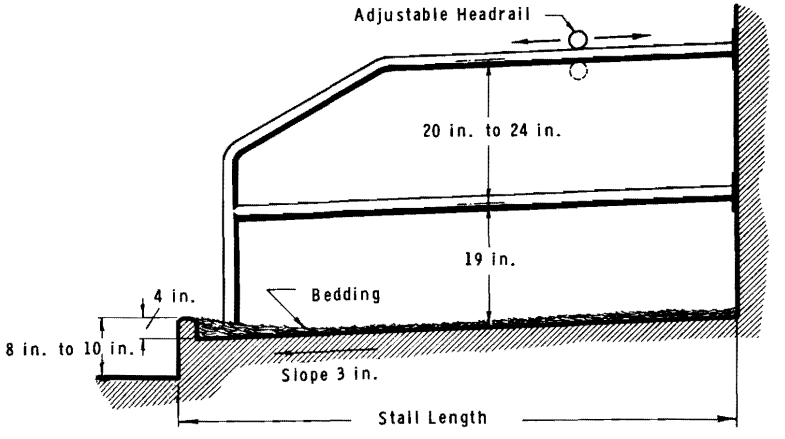


FIGURE 2-O
FREE STALL WITH PAVED ELEVATED PLATFORM

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Reference has been made throughout this document to the National Building Code of Canada, 1970. Copies of the National Building Code and its supplements can be obtained by writing to:

THE SECRETARY,
ASSOCIATE COMMITTEE ON THE NATIONAL BUILDING CODE,
NATIONAL RESEARCH COUNCIL,
OTTAWA 7, CANADA.