Guidelines for Use of Thermal Insulation in Agricultural Buildings

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1 Purpose and Scope

This Standard establishes guidelines for evaluating and specifying the type, amount, and manner of installation of thermal insulation in agricultural buildings. The scope includes consideration of burning characteristics, insulation values, and proper installation and protection of insulating materials.

2 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Standards organizations maintain registers of currently valid standards.

ASAE EP475, Design and Management of Storages for Bulk, Fall-Crop Irish Potatoes

ASHRAE, Handbook of Fundamentals


ASTM C236-89, Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box


ASTM C976-90, Test Method for Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box


ASTM E84-91a, Test Method for Surface Burning Characteristics of Building Materials
3 Definitions

3.1 An agricultural building is defined as a building primarily designed to house or store farm implements, hay, poultry, livestock, or other animal or plant products. Such a structure may be used part-time, temporarily, or seasonally for work involved with agricultural production. This structure is not to be considered a place of human habitation or one regularly used by the public.

3.2 Insulating material (insulation) is defined as any material installed for the primary purpose of reducing heat transmission.

4 Burning Characteristics Evaluation

4.1 Insulation that has passed either FM 4880, UL 1715, UL 1040, or UBC 17-5; and that has a flame spread of 25 or less and smoke production of 450 or less when tested in accordance with ASTM E84, when tested at the thickness and installation planned in actual agricultural building construction, may be installed in an exposed manner to the interior of the building. Installation assemblies not meeting these requirements shall be separated from the interior of the building by an ignition/thermal barrier as specified in 4.3.

4.2 Vapor retarders or facers that are exposed to the interior of agricultural buildings shall be tested for flame spread and smoke production in accordance with the methods presented in 4.1. Materials that do not have a flame spread of 25 or less and smoke production of 450 or less shall meet the requirements of 4.3.

4.3 Insulation, vapor retarders, or facers that have a flame spread of 75 or less and smoke production of 450 or less when tested in accordance with ASTM E84, but not meeting requirements of 4.1 or 4.2, shall be separated from the interior of the building by an ignition/15 min thermal barrier capable of providing protection comparable to 13 mm (1/2 in.) cement plaster, 13 mm (1/2 in.) fire-retardant treated plywood, 13 mm (1/2 in.) fire-rated gypsum wallboard, 3 mm (1/8 in.) mineral board, 16 mm (5/8 in.) exterior type plywood, 13 mm (1/2 in.) spray applied Zonolite 3306 (UL/FM), 25 mm (1 in.) spray applied ThermoCon (architectural white or off white only) (UL/FM), 25 mm (1 in.) masonry or concrete or other material that performs similarly when tested in accordance with ASTM E119.

4.4 Materials with a flame spread greater than 75 and/or smoke production greater than 450 when tested in accordance with ASTM E84 may need specified protection that is not addressed in this Standard.

5 Insulation Values

5.1 The insulation values of the various insulation materials shall be as established and published in the latest edition of ASHRAE Handbook of Fundamentals, or as determined by a National Voluntary Laboratory Accreditation Program, NVLAP, laboratory accredited for accepted thermal test procedures. Mean insulation temperature and heat flow direction affect the insulation values. Select values or test at conditions that are representative of expected use conditions. Accepted thermal test procedures are ASTM C518, C177, C236, C976, or C1114. Laboratory test results should be made available upon request.
5.2 Installation of the insulation shall be according to manufacturers’ recommendations and in a manner that will not contribute to degradation of the thermal properties of the insulation. If degradation is unavoidable, the loss in insulation value should be taken into account during the design, and long-term, aged insulation values should be used in the analysis.

5.3 The amount of insulation and thus the assembly U-values needed in agricultural buildings depends on many factors, such as the expected outside temperature, number and size of animals or quantity of plant products housed, desired inside temperature, cost of material and installation, consequences of wear and condensation, operating cost for heating and/or cooling based on present and projected costs, and critical nature of building and contents being insulated. Table 1 lists recommended minimum insulation levels for agricultural buildings. More insulation may be justified with increasing energy costs in supplementally heated buildings.

Table 1 – Minimum recommended overall coefficients of heat transmission, U, for insulated assemblies † (ref. MWPS)

<table>
<thead>
<tr>
<th>Climatic Zone‡</th>
<th>Recommended Minimum U# Values</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cold</td>
<td>Modified Environment</td>
</tr>
<tr>
<td></td>
<td>Walls Ceiling</td>
<td>Walls Ceiling</td>
</tr>
<tr>
<td></td>
<td>W/(m² K)</td>
<td>Btu/(h ft² °F)</td>
</tr>
<tr>
<td>1</td>
<td>0.91§</td>
<td>0.91§</td>
</tr>
<tr>
<td>2</td>
<td>0.91</td>
<td>0.91</td>
</tr>
<tr>
<td>3</td>
<td>0.91</td>
<td>0.48</td>
</tr>
</tbody>
</table>

* Use assembly U-values which include framing effects, air spaces, airfilms, linings, and sidings. Determine assembly U-values by testing the full assembly in accordance with ASTM C236 or C976 or calculate by the procedures presented in the ASHRAE Handbook of Fundamentals.
† The values shown do not represent the values necessary to provide a heat balance between heat produced by products or animals and the heat transferred through the building.
# For poultry grow-out buildings, a U of 0.63 – 0.81 W/(m² K)[0.11 – 0.14 Btu/(h·ft²·°F)] in the roof and walls is current practice.
‡ Refer to Figure 1.
§ Where ambient temperature and radiant heat load are severe, use a U of 0.48 W/(m² K)[0.083 Btu/(h·ft²·°F)].

5.3.1 Cold buildings have indoor conditions about the same as outside conditions. Examples are machinery storages, cold free stall barns, and open front livestock buildings. Minimum insulation is frequently
recommended in the roof of these buildings to reduce solar heat gain in summer and to reduce condensation in winter.

5.3.2 Modified environment buildings rely on insulation, natural ventilation, and animal heat to remove moisture and to maintain the inside within a specified temperature range. Examples are warm free stall barns, poultry production buildings, and swine finishing units.

5.3.3 Supplementally heated buildings require insulation, ventilation, and extra heat to maintain the desired inside temperature and humidity. Examples are farrowing buildings, plant product storages, farm shops, and offices. Cold and modified environment buildings requiring supplemental heat in a small area, such as brooders in an open front building, are not classified as supplementally heated. Table 1 lists recommended minimum insulation levels for agricultural buildings. More insulation may be justified with increasing energy costs in supplementally heated buildings.

6 Installation

6.1 Insulation should be chosen and installed after due consideration is given to the temperature extremes which will be encountered. Some plastic insulations melt at elevated temperatures. Some insulations lose their fire retardation properties under long-term elevated temperature and humidity conditions. Some absorb moisture, which reduces insulation value, in high humidity conditions. Some insulations may cause corrosive reactions with building components.

6.2 The insulation or covering materials should be durable, cleanable, moisture resistant, non-toxic to livestock, and consistent with applicable FDA regulations. There should be no transfer of odor, taste, or toxicity to food and feed products stored in the building.

6.3 Insulation immediately adjacent to heaters, electrical panels and devices, and welding operations is more susceptible to fire and melting. Flammable insulation in these and other similarly hazardous areas should be protected with ignition barriers as defined in 4.3.

6.4 Extreme care shall be taken when using a torch, welder, etc., around insulation during construction or renovation of a building. A person with a fire extinguisher shall maintain a fire watch during work and for at least two hours after work is complete.

6.5 Insulation should be installed in such a manner that a reasonably uniform insulation value exists over the entire insulated area.

6.6 Insulation should be installed so that it will not unacceptably settle or sag. Insulation, if susceptible to deterioration from ultraviolet light, should be protected from the sun.

6.7 Insulation should be chosen and installed in a manner that will discourage the entrance and chewing by rodents, pecking by birds, infestation by insects, and damage by livestock.

6.8 A vapor retarder should be chosen and installed with the insulation that provides a permanent resistance to the passage of water vapor of 14.3 ng/Pa·s·m² (0.25 perms) or less when installed. Vapor retarders shall be evaluated and installed in conformance with the latest edition of ASHRAE Handbook of Fundamentals.

6.9 When there is a possibility of moisture migrating through the insulation, the wall or roof section shall be constructed so that the moisture can escape on the cold side.

7 Miscellaneous Considerations

7.1 Full-scale building fire tests (ref. Hagan, 1981) conducted by insulation manufacturers on unoccupied buildings with various installation configurations, types, and amounts of insulation (all with 25 or less flame
spread ratings according to ASTM E84) show that flammable material within the building may burn rapidly due to higher heat retention in well-insulated buildings.

7.2 Because of the intense heat build up possible in a well insulated building, consideration should be given to the use of automatic heat and smoke vents or burn-out panels and skylights in large, valuable buildings.

7.3 For storage buildings with very high relative humidity (85-95%) refer to ASAE EP475 or other appropriate guidelines.

Annex A
(informative)

Bibliography

The following documents are cited as reference sources used in development of this Engineering Practice: