Prevention of Wind and Fire Losses to Farm Buildings

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Prevention of Wind and Fire Losses to Farm Buildings

By Henry Giese

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# CONTENTS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Resistive Construction</td>
<td>3</td>
</tr>
<tr>
<td>Effect of Bracing Upon Frame Walls</td>
<td>6</td>
</tr>
<tr>
<td>Considerations in Farmstead Planning</td>
<td>9</td>
</tr>
<tr>
<td>Ridge Fastening</td>
<td>10</td>
</tr>
<tr>
<td>Splicing and Sheathing</td>
<td>10</td>
</tr>
<tr>
<td>Bracing at Mow Floor</td>
<td>10</td>
</tr>
<tr>
<td>Anchoring to Foundation</td>
<td>11</td>
</tr>
<tr>
<td>The Roof Truss</td>
<td>13</td>
</tr>
<tr>
<td>Miscellaneous Details</td>
<td>14</td>
</tr>
<tr>
<td>Fire Resistive Construction</td>
<td>15</td>
</tr>
<tr>
<td>Location of Buildings</td>
<td>16</td>
</tr>
<tr>
<td>Sparks on Non-resistive Roofs</td>
<td>16</td>
</tr>
<tr>
<td>Defective Flues and Heating Apparatus</td>
<td>17</td>
</tr>
<tr>
<td>Fire Stoppage</td>
<td>19</td>
</tr>
<tr>
<td>Defective Electric Wiring</td>
<td>19</td>
</tr>
<tr>
<td>Lightning</td>
<td>20</td>
</tr>
<tr>
<td>Spontaneous Ignition</td>
<td>20</td>
</tr>
<tr>
<td>Chlorates Used in Killing Weeds</td>
<td>21</td>
</tr>
<tr>
<td>Gasoline and Kerosene</td>
<td>22</td>
</tr>
<tr>
<td>Matches and CARELESS Smoking</td>
<td>22</td>
</tr>
<tr>
<td>Disposal of Ashes and Rubbish</td>
<td>22</td>
</tr>
<tr>
<td>Sources of Further Information</td>
<td>22</td>
</tr>
<tr>
<td>Publications Dealing with Wind and Fire Losses and Their Prevention</td>
<td>23</td>
</tr>
</tbody>
</table>
Prevention of Wind and Fire Losses to Farm Buildings

BY HENRY GIESE

The amount of farm property destroyed annually by wind and fire is appalling, and this loss constitutes a heavy financial drain upon the state and nation. In many instances, the losses are due to carelessness or improper construction of buildings and might easily be prevented. Since prevention of the loss of a building is much better than reconstruction, this circular purposes to call attention to some of the easily observed preventive measures which if followed will reduce farm building losses resulting from wind and fire.

WIND RESISTIVE CONSTRUCTION

The action of wind upon buildings has not been well understood. Wind pressures in some instances act in quite the reverse direction to what one might ordinarily expect.

In general, two types of storms cause damage to buildings. The first is the tornado, a very rapid whirl of small diameter; the second is the cyclone or hurricane, which is of such large diameter that it appears to be a straight wind.

The tornado is so whimsical and destructive in its action and affects such a relatively small territory, that it does not now seem practical to attempt to build to resist it. On the other hand, it is feasible to build against the high and apparently straight wind which does the greater part of the total damage.

We shall discuss briefly the effect of air in motion upon objects in its path, the parts of buildings which seem to fail to resist these forces and some suggestions as to how they may be strengthened. The weight of the atmosphere exerts a pressure of nearly 15 pounds per square inch upon all exposed surfaces near the earth. Every square foot of surface on a building must resist a pressure of more than a ton due to the atmosphere. This pressure is not apparent since it is equal on each side of a board or on the inside and outside of a building. That is, on every square foot of barn wall or roof, there is a pressure of more than a ton tending to force the wall in and an equal outward pressure. As long as these two forces are equal, the building stands without difficulty.

When the air outside the building is in motion, this equilibrium in pressure is upset. The most common change in pressure is an increase on the windward side. This force has been esti-
mated by designers to reach approximately 30 pounds per square foot for winds in this area. Thus while the atmospheric pressure of approximately a ton to the square foot is increased by about 30 pounds, the pressure on the leeward side remains the same.

One principle which has not been so well understood is that when air flows past a surface, the static pressure is decreased on that side. This can easily be illustrated by a sheet of paper and spool as shown in fig. 1. Stick a pin thru a piece of paper to prevent its sliding off, and hold the paper against the end of the spool with the pin in the hole of the spool. If one blows into the other end of the spool, it will be found impossible to blow the paper from the opposite end, because the air escaping from the hole in the spool, flows parallel to the surface of the paper. This flow of air parallel to the paper reduces the static pressure on the side toward the spool while the static pressure on the other side remains undiminished. This difference in pressure is sufficient to hold the paper disc firmly against the end of the spool.

Wind flowing over a barn and past the ends or sides may act in much the same way. Figure 2 illustrates approximately the influence of a wind from the left upon the sides and roof of a gambrel roofed barn. A considerable pressure is built up on the vertical side and steep part of the roof on the windward side. A suction probably exists over all of the remaining portions. The length of the arrows indicates roughly the difference in pressures or the force effective at each point. The arrow heads show the direction of the effective pressure. The pressure is outward over a large portion of the barn area because the pressure on the outside is decreased while that on the inside remains approximately the same. Open windows on either the windward or leeward side will change this situation materially.

Most farm buildings now in use have not been built to withstand this difference in pressure. On
the other hand, a few simple anchors and braces added to existing buildings or included in the construction of new buildings may save a building and its contents in a severe storm. The general principles of bracing and a few construction details which will help in strengthening buildings against these wind pressures will be considered.

In most farm buildings, the principal members are either horizontal or vertical. Horizontal siding is nailed on vertical studding, or vertical studding is nailed on horizontal members. The effect of wind pressure on a structure of this kind is illustrated in fig. 3. In a and b, the nails alone resist the force applied by the wind. The nails bend or split the wood and the structure is deformed from its original shape. A small diagonal brace, as shown in c and d (fig. 3), adds greatly to the stiffness and strength.

Figure 4 shows the effect of bracing upon crib siding or a tightly sheathed wall after the lumber has dried out and cracks

left between the boards. The construction at the left is very flimsy and will easily settle out of shape, while that at the right is very strong and rigid. The result of a failure to brace well is illustrated in fig. 5.

In most wood construction, the weakest places are at the joints. The proper fastening of members requires careful workmanship and often the strength of a beam is materially lessened because of ineffective fastening. All joints should be well nailed or bolted with due care to avoid splitting. A nail is not very effective at best and may be nearly worthless if it is driven so as to split the wood.
The following results of tests made by the U. S. Forest Products Laboratory* at Madison, Wis., show very clearly the effect of bracing upon the strength and rigidity of frame walls.

INCLINATION OF SHEATHING

1. "Ordinary stud and plate walls, sheathed diagonally, are 4 to 7 times as stiff and 7 to 8 times as strong as if horizontally sheathed.

FREQUENCY OF NAILING

2. Three or four nails instead of two in 1 x 8 horizontal sheathing improve the wall but little. They add from 30 to 100 percent to the stiffness of a diagonally sheathed wall.

SIZE OF NAILS

3. Ten-penny nails instead of eighths for horizontal sheathing increase stiffness 50 percent and strength 40 percent. Larger nails do not improve diagonal sheathing.

EFFECT OF MATCHING

4. Side and end-matched sheathing is as stiff and strong as sheathing which butts over the studs.

EFFECT OF GREEN LUMBER

5. A wall horizontally sheathed with green lumber and allowed to become air dry before testing lost about 50 percent in stiffness and 30 percent in strength as compared to a dry sheathed panel.

TYPES OF BRACING

6. "Herringbone" bracing has little value.
7. 2 x 4 corner braces cut in between studs add 60 percent to stiffness and 40 percent to strength.
8. 1 x 4 strips, let into the stud faces diagonally under sheathing, make a horizontally sheathed wall 2 1/2 to 4 times stiffer and 3 1/2 to 4 times stronger.

EFFECT OF WALL OPENINGS

9. Window and door openings closely spaced reduce the stiffness of horizontally sheathed walls 30 percent and their strength 20 percent. Diagonally sheathed walls lose 63 percent in stiffness and 50 percent in strength, but are still much better than horizontal walls without openings.

EFFECT OF LATH AND PLASTER

10. Plaster on wood lath makes a wall 90 percent stiffer, and about half as strong as the diagonally sheathed."

So little difference in the labor and materials is involved between a rigid and a flimsy wall that it seems almost inexcusable to construct a building without wall bracing. The most commonly damaged buildings from lack of wall bracing are corn cribs. Common crib construction consists of narrow horizontal siding boards, spaced about an inch apart and nailed to vertical studs. This construction is very weak and flimsy. The siding should either be laid diagonally or the wall well braced. Existing cribs can be easily strengthened by nailing one or more 1 x 4's diagonally across the inner face of the studs. In

Fig. 6. House damaged by flying debris from a poorly constructed barn.
new construction, it would be better to let the brace into the studs as shown in fig. 4.

In the older buildings which were built when lumber was plentiful and labor cheap, the barn frame was constructed of heavy timber mortised and tenoned together. Many of these still stand because of the tremendous amount of material used. Newer construction has in some instances gone to the other extreme. Conservation of labor and materials has brought the balloon frame construction. Members built up from planking make it possible to discard many defects which would appear in larger timbers and also reduce the number of sizes which must be stocked by the local lumberman. The modern types of barn frames have also provided better working space in the barn, especially in the haymow.

While these new methods of framing may be entirely satisfactory from the construction standpoint, lack of attention to
some details may permit destruction of an otherwise satisfactory buildings. The following discussion relates primarily to barns because studies have shown that the greatest economic damages are to barns. Some of the suggestions will apply to other buildings as well. The house is usually of better construction and more thoroly braced by partition walls and, hence, usually does not suffer major damage unless struck by flying debris from other buildings.

**CONSIDERATIONS IN FARMSTEAD PLANNING**

According to statistics on weather, nearly all destructive winds in Iowa blow from the west with slight variations toward the north or south of west. It would seem advisable, then, in planning the location of buildings to consider this fact. In the storm area of Sioux and O'Brien counties (June, 1930) there were a number of occasions where houses and other buildings were badly damaged by other buildings. The house shown in fig. 6 was located directly east of the barn. The barn, of questionable construction and not anchored to the foundation, was easily demolished. It may be noted that the walls and roof of the barn gave way in sections, each in turn piling against the house. Altho still standing, the house was so badly racked from the impact as to be almost a total loss. Figure 7 shows the damage to a first-class corn crib from the same cause. In this case, the owner had spared no cost in an attempt to secure a good barn. Sufficient material was used, but it was improperly fastened in place.

![Fig. 8. Influence of wind on joints at plate line.](image)

**PLATES AND RAFTERS**

From observations in storm areas, the improper fastening of plates and rafters to the top of a frame wall appears to be the most common cause for destruction of buildings in a high wind. Figure 8 shows common methods of construction used. Nails are

![Fig. 9. Roof torn from building when rafters pulled from plate.](image)
driven thru the plates into the ends of the studs. Rafters are toe-nailed then to the plate. Nails driven into the end grain and toe-nailing are poor methods of fastening; they should be avoided where possible. This construction is satisfactory on the windward side or where the roof is sufficiently heavy to balance the lifting effect of the wind. On the leeward side, pressures resulting from the wind cause forces in the directions shown by the arrows. This pulls the rafters from the plate or the plate from the studs. Figure 9 shows how this has occurred. A 1 x 6 brace, as shown in Fig. 10, will add very little to the cost of new construction and may easily be applied to old barns. This small precaution may prevent the loss of an entire barn.

RIDGE FASTENING

Similar stresses occur at the ridge of the barn. Rafter ends at the ridge should be securely fastened in the same manner as are recommended for fastening rafters to the plate.

SPLICING AND SHEATHING

Precaution should be taken by the builder to avoid splicing sheathing boards on the same stud or rafter. A building should be as nearly as possible equally strong in all places. Figure 11 shows how a roof has pulled apart because of failure to observe this precaution.

BRACING AT MOW FLOOR

The side pressure of the wind on a barn tends to move it from its foundation. If the building is relatively short the braces at the ends may be sufficient to hold the barn in its original shape. The building can
be materially strengthened by adding a brace as shown in fig. 12. The barn shown in fig. 13 has been twisted out of shape because of a lack of bracing. The customary way of supporting the mow floor is by letting in a ribbon. This notch may reduce the bending strength of the stud by one-third or more. The barn shown in figs. 14 and 15 was judged a total loss because all of the studs were broken just below the mow floor. Rafters and studs above the floor remained practically intact.

ANCHORING TO FOUNDATION

Even tho the building were built sufficiently strong to withstand the action of a severe wind, it
might be weakened by being blown from its foundation. The hog house shown in figs. 16 and 17 was bent and moved from its foundation at both ends. The resistance of the concrete floor, which extended approximately an inch above the foundation, was sufficient to keep the center part in place and to prevent the entire building from being blown away. A few well placed anchor bolts would have prevented damage to this building. In the barn shown in fig. 18 anchor bolts were provided in the foundation but nuts were never screwed onto the bolts. Since this was the barn that partially demolished the corn crib shown previously, much damage might have been prevented by the screwing of a few nuts onto bolts already in place. Figure 19 illustrates a common way of anchoring the sill by bolts imbedded in the foundation. As the studs are usually only toe-nailed to the sill, this joint has some weaknesses described of a similar fastening of the rafters and plate to the studs.
Vertical siding nailed to the sill or provision to anchor even a few studs directly to the foundation would add to the effectiveness. Figures 20 and 21 show buildings upturned for lack of anchoring.

THE ROOF TRUSS

With changes in barn framing has come a demand for a haymow unobstructed by timbers. Several types have been designed which if properly constructed will give entire satisfaction. The gambrel, or often mis-called hip roof, has been an outgrowth of this tendency. This double slope roof, steep next the plate and relatively flat above, allows more mow space with a given wall height and permits bracing the roof to avoid inside supports. The Shawver and braced rafter roofs have both proved very satisfactory. The roof on the barn shown in figs. 14 and 15 was of the braced rafter type and withstood the storm quite effectively. Before one builds a roof of this type, however, he should assure himself that he is building from a proved design.

A more recent development in roof design is the curved or so-called gothic. This has been very popular because of its pleasing appearance and its conveniently shaped mow, free from obstructions. While it is possible to build these roofs so that they will retain their shape thru wind storms, many have been improperly designed and have consequently collapsed or sagged badly. Two types of rafter construction commonly used are shown in fig. 22. The bent rafter construction shown on the left requires less material and is easier to construct. It is, however, structurally weak and if used at all should be supplemented by an occasional sawed rafter as shown on the right side. Other methods are now being used satisfactorily for this type of construction. Again the builder
should convince himself that the proposed method has proved itself capable of satisfactory performance.

**MISCELLANEOUS DETAILS**

Some of the above suggestions will apply in principle to details not specifically mentioned. In addition, attention should be called to some minor causes of damage which in the aggregate cause a great deal of inconvenience and often large property damage. Some of these while not strictly structural problems in themselves, may cause damage to other buildings or parts of buildings. One of the most common is the blowing off of cupolas. Many wooden cupolas are merely toe-nailed to barn roofs. After a few years the nails rust and the timber
decays around the nail. A cupola blowing from a roof (fig. 23) may damage the barn on its way down or strike livestock. Barn doors should be securely fastened. Sliding doors should be held by guides at the bottom as well as be hung on a track which will not permit their being blown off. Falling defective trees cause much damage to buildings and loss of livestock. Trees or limbs that are not sound should be removed. Windmills should be securely braced and anchored.

**FIRE RESISTIVE CONSTRUCTION**

Fire is one of the most insidious of farm hazards. Its annual toll in the United States has been variously estimated at upwards of $100,000,000. In addition to causing this tremendous property damage it is the cause of approximately 3,500 deaths each year. Because of the relative isolation of one farm from other farms the fire problem offers some additional difficulties not encountered near population centers. The Iowa state fire marshal reports more than six times as many fires in city dwellings as farm dwellings in 1929, while the total damage was about equal in each case. The increased difficulty in fighting farm fires and consequent decrease in probability of being able to extinguish them, emphasizes the need for preventive measures on farms and in rural communities. Fire losses are truly economic losses and must eventually be borne by society. Insurance does not adequately cover loss of property, time and inconvenience involved and nothing can replace the loss of life. Since the owner must be the larger loser, it is in his interest to do what he can toward fire prevention as well as fire protection.

The purpose of this bulletin is to discuss the major causes of farm fires and some easily observed preventive measures. There are, in general, two types of problems: those definitely related to defective construction and maintenance and those resulting from carelessness. Both may be lessened by proper construction and so are included here. A press release from the United

![Fig. 23. Cupola blown from barn may kill livestock.](image)
States Department of Agriculture states: "The principal causes of farm fires and damage as compiled by the engineers are: spontaneous ignition of agricultural products, $30,000,000 annually; lightning $21,650,000; defective chimneys and flues, $20,125,000; sparks on combustible roofs, $9,350,000; careless use and storage of gasoline and kerosene, $6,650,000; defective heating equipment, $6,375,000; and faulty wiring and improper use of electrical appliances, $1,225,000. Fire of miscellaneous known origin accounts for more than $12,000,000 of the annual loss; and $30,000,000 in damage is from causes not identified. This loss from unknown causes combined with the annual loss from spontaneous ignition represents 40 percent of the total farm fire loss."

These groups have each been further subdivided into more specific causes and are discussed below with some suggestions for better construction which will eliminate or lessen the loss caused thereby.

LOCATION OF BUILDINGS

When planning a farmstead or adding buildings to the group, the location of buildings within the group should be considered. Unless of fire resistive construction, the buildings should be well separated and located, in so far as possible, so that fire will not be readily carried from one to another. If the principal buildings are arranged so that a line drawn from one to the other makes a right angle with the direction of the prevailing wind, there will be less chance for fire to be carried from one building to the other. Dwelling fires occur more frequently during the heating season, while barn fires occur more often in the summertime. This relation of buildings not only minimizes the danger of fire spreading from one building to another, but also reduces the probability of objectionable odors reaching the house from the stables.

SPARKS ON NON-RESISTIVE ROOFS

Sometimes notwithstanding a careful arrangement of buildings, fires will occur when the wind is blowing from some other than the prevailing direction. Sparks and flying brands from the burning building may seriously endanger other buildings in the farmstead unless they are properly protected. Sparks from the chimney may lodge on a combustible roof and cause a serious fire. As noted previously, this one cause is responsible for a large proportion of the total farm fire loss. Experience has shown that a non-combustible roof of tile, metal or slate or some of the more fire resistant materials will prevent the spread of many severe fires.

If wood shingles are employed proper use will help in making
the roof more fire resistant. Cheap grades should be avoided. Flat grained shingles will curl badly. Edge grained cost slightly more but will last much longer. Do not try to cover too much surface with a thousand shingles. Shingles laid 5 inches to the weather do not have sufficient support and will soon work loose. Lay them with an exposure not to exceed \(4\frac{1}{4}''\) to \(4\frac{1}{2}''\). It has been demonstrated that new wood shingles lying flat on the roof do not ignite readily. The hazard increases rapidly as they split and warp. Do not expect a roof to last too long. Renew it. Dipping wood shingles in paint before laying will make them more fire resistant.

DEFECTIVE FLUES AND HEATING APPARATUS

Be sure that furnaces, stoves and other heating equipment are carefully installed. All should be well separated from frame walls. Fireplaces should be well protected on all sides. Stove and smoke pipes leading to the chimney should be of substantial construction and well fastened. Care should be taken to renew them before they have rusted thru and constitute a fire hazard.

In recent years there has been an increasing tendency toward hatching chicks earlier. To do this requires heated incubators and brooders. Many of these are fire hazards and should be kept in small buildings well separated from the larger farm buildings. In case this is not feasible, great care should be exercised in their installation and operation.

Many fires result from poor chimney construction. Cement mortar, or mortar containing only a small percentage of lime, should be used in laying a chimney. The acids formed in the chimney deteriorate lime mortar rapidly and cracks may occur extending thru the chimney wall (fig. 24). Existing chimneys should be examined regularly. Pick the mortar with a penknife or
other sharp instrument. If it crumbles readily it should be renewed. Examine the chimney for cracks. The safest way when building is to line the chimney with a clay flue liner. This eliminates many mortar joints and the probability of a continuous mortar joint thru the flue wall. Chimneys should never be built upon a wood or other combustible support but should be carried down to a masonry foundation. No wood
work should be built into or in contact with a chimney. They should be separated with asbestos or other non-combustible insulating material.

**FIRE STOPPAGE**

When a building constructed of combustible material is ignited, the rate of burning depends largely upon the methods of construction used. Many fires originate in the basement. In the usual frame house construction, flues are formed between the studs and the sheathing and fire may travel readily up thru the wall to the floors above. A fire of this kind is very difficult to fight as one never knows just where it may break out next. This flue action can be lessened and the progress of fire thru a frame building materially retarded by the use of fire stops. These fire stops, altho preferably of non-combustible material, may, if well fitted, be of wood. The places where the fire stops are most effective in a house are around all walls next to the foundation, between floor levels and at the roof line. Figures 25, 26, 27, 28 show several methods of accomplishing this. The travel of fire from the stable of a barn to the mow or from the mow down may be prevented or retarded by equipping each opening with a metal covered door and constructing the mow floor by nailing 2 x 4's together as shown in fig. 29 in place of the usual joist construction. Many times valuable livestock is burned because of a lack of time for removal from a burning building.

**DEFECTIVE ELECTRIC WIRING**

The increasing use of electricity on the farm brings with it increasing danger of fires from electrical apparatus. Some times a desire to econo-
mize, or lack of information regarding the fire hazard, result in faulty installation. All wiring on the farm should conform to the National Electric Code prepared by the electrical committee of the National Fire Protection Association. Avoid open wiring. The insulation will deteriorate after a time or may become worn or gnawed off by rats. Use only conduits or other protective covering and make all connections in fireproof boxes. Large switches and motors or generators that are liable to arc during operation should be well protected. Transformers or other equipment that are likely to become hot should be kept at a safe distance from combustible materials. Never replace fuses with nails or wires or with fuses of too high amperage. Be sure to disconnect flatirons, curling irons or other heating equipment before leaving them. Protect with suitable guards any lights used in barns or lights that may be broken and possibly ignite combustible material.

LIGHTNING

Lightning is one of the major causes of farm fire loss in the Middlewest. Preventive measures have been demonstrated to be more than 90 percent efficient. Few fires occur in buildings properly roded. Farmers’ Bulletin No. 1512 published by the U. S. Dept. of Agriculture gives specific directions for equipment for protection against lightning. Two general considerations are (1) a pointed air terminal extending above the roof or chimney and (2) a good electrical connection to permanent earth moisture.

SPONTANEOUS IGNITION

The spontaneous ignition of hay is the largest single cause
of farm fires. Careful curing is essential to safe storage. Henry G. Knight, Chief of the U. S. Bureau of Chemistry and Soils, states:

"Difficulty is experienced in some of the states in curing leguminous hays by the ordinary methods. The stems are rather large and juicy and unless there is good drying weather curing takes place rather slowly. If a considerable amount of moisture is left in the hay it is conducive to heating. Upon the other hand it is common practice in certain western states in handling alfalfa to cut it, allow it to wilt, and then immediately place it in the stacks. Under such conditions the material undergoes heating and the color changes to tobacco brown. It very seldom fires but forms a sort of ensilage which apparently is very palatable to livestock. It is common knowledge, however, that it is dangerous to put up alfalfa or clovers after a heavy dew even tho the total amount of moisture in the hay may be apparently far less than in the case stated above. Hays that are stacked in the open as is the common practice throughout the west may heat and ignite, but ordinarily only the one stack is lost and such losses may not be reported. Hays which are stored in the barn which undergo spontaneous heating and ignition not only cause the loss of the hay but other property as well."

The spreading of salt over the hay at the rate of about 20 pounds per ton gives slight protection.

**CHLORATES USED IN KILLING WEEDS**

The recently developed practices of using chlorates to kill weeds has added a new fire hazard to the already long list. This chemical may be safely used if the proper precautions are taken. Instructions for use are usually placed in the drums with the chemical. The following warning is issued by R. H. Porter of the Iowa Agricultural Extension Service.

"Several experiment stations have been recommending sodium chlorate to kill such weeds as canada thistle, quack grass and European bindweed. Tests with this chemical have not been as extensive in Iowa as in certain other states but we have enough evidence now to show that sodium chlorate in liquid form when properly applied will kill canada thistle and quack grass. But there are certain dangers in using chlorate which makes us reluctant to recommend it for general use.

"Sodium chlorate is relatively harmless when packed in a steel or iron drum and kept closed and can be handled with little or no danger. Organic matter or dust when mixed with chlorate renders it highly inflammable. Clothing, wood or other

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organic matter when soaked in sodium chlorate solution may be easily set on fire by friction and often explodes. A person walking thru a field recently sprayed with sodium chlorate may suddenly find himself surrounded by flames. One area in Iowa sprayed during 1929 at the rate of 500 gallons per acre (12½ quarts per square rod) caught on fire spontaneously on a hot sunshiny day.”

GASOLINE AND KEROSENE

Gasoline and kerosene have many farm uses. Care in use and storage will materially reduce the property loss and hazard to life. Stoves and lamps should be filed by daylight and away from open fires. Lamps should be protected against accidental tipping which might result in spilling oil on the floor. The use of kerosene for quickening fires is a dangerous practice. Many fatal accidents have resulted from home cleaning with gasoline. Some fabrics when rubbed together or against other materials will produce sparks sufficient to ignite gasoline vapors. Use only non-combustible cleaning fluids. Inflammable liquids should be stored only in well marked containers and kept away from anything which might produce a fire.

MATCHES AND CARELESS SMOKING

Matches and careless smoking have been the cause of many fires. Too much care cannot be taken to see that matches are stored away from fires and are inaccessible to children. Safety matches are preferable. Cigar and cigarette butts should be entirely extinguished before being thrown away. Hay and other combustible material around barns, as well as in forests and fields, are very easily ignited. Smoking should not be tolerated in barns and other buildings.

DISPOSAL OF ASHES AND RUBBISH

Metal cans or receptacles should be provided for ashes. Live coals may remain for a long time after ashes are removed from the stove or furnace. Especially in dry seasons, ashes should never be emptied where they may be scattered by the wind. Rubbish should not be allowed to accumulate but should be burned or hauled away where it cannot be ignited and cause damage to buildings or other property.

SOURCES OF FURTHER INFORMATION

An attempt has been made here to review the causes of wind and fire damage and to suggest reasonable measures which if
adopted would help materially to reduce economic losses and hazards to human life. These have been treated only briefly. For the benefit of those who may desire to read further, a list of publications is given. Copies can be secured upon application to the addresses given.

PUBLICATIONS DEALING WITH WIND AND FIRE LOSSES AND THEIR PREVENTION

1. BETTS, M. C., ET AL.

2. BROWNE, CHARLES A.

3. DRYDEN, H. L., AND HILL, C. L.

4. MOCK, GEO. D.

5. MOCK, GEO. D.

6. NATIONAL BOARD OF FIRE UNDERWRITERS.
   Safeguarding the Farm Against Fire. National Bd. Fire Underwriters. 207 E. Ohio St., Chicago.

7. NATIONAL BOARD OF FIRE UNDERWRITERS.

8. ROETTIE, HARRY E.

9. STROHM, JOHN W.

10. STROHM, JOHN W.

11. UNITED STATES.
    Light Frame Construction. Bulletin No. 145. Issued by the Federal Board for Vocational Education in Cooperation with the National Committee on Wood Utilization. U. S. Dept. of Commerce. (40 cents per copy.)

12. VALGEN, V. N., ET AL.