

## CHARACTERIZING LIGHTING AND MARKING ON FARM EQUIPMENT IN CURRENT USE

The Uniform Vehicle Code (UVC) and the lighting provided by manufacturers on agricultural equipment were both moving forward, incrementally, evolving roughly in sync on parallel tracks into the middle 1950's. Thereafter, both the consensus standards (a third track) and what manufacturers provided improved regularly and neither the model UVC nor the requirements of U.S. states (a fourth track) kept pace.

Two decades later and several iterations in UVC provisions, one-third of states still required only the minimal lighting devices that were considered feasible four decades earlier. The 1971 Secretary of Transportation's report to Congress concluded that if immediate corrective action was necessary, enabling legislation at the state level based on the UVC was the mechanism recommended to improve illumination and turn signaling. Furthermore, such legislation should be developed to address retrofit since it would otherwise estimated to take 30 years before new lighting presentations would be predominate if they were introduced solely on new equipment.<sup>(1)</sup>

Voluntary, consensus standards and industry practices for the lighting and marking on newly manufactured equipment were well in the lead at the time of the Secretary's report and remain so today. Heretofore no actions have successfully compelled users of older agricultural equipment on roadways to keep lighting maintained as produced, or to upgrade it with the most-efficacious, crash-preventing features of current lighting prescribed in industry-leading standards.

Today's motorists on rural roadways can expect to mainly encounter agricultural equipment with presentations of lighting and marking that conform to the standards applicable at the time the host product was produced. That principle alone yields substantial variety by evolution. The motoring public should also expect to see agricultural equipment, especially in daytime use, without lighting and marking or with only the lighting and marking dictated by local requirements enforced in the area.

## INTRODUCTION

Agricultural equipment is broadly divided into agricultural field equipment and agricultural farmstead equipment.<sup>(2)</sup> Agricultural field equipment is further subdivided into agricultural tractors, self-propelled machines, and agricultural implements. Equipment that is not agricultural field equipment is agricultural farmstead equipment, such as material handling equipment, milling systems, crop dryers, and livestock feeding systems. Farm vehicles, terminology often used in motor vehicle legislation and road regulations, is nomenclature that particularly chaffs many farmers and ranchers because it suggests registration, licensing, and the associated hassle, tracking, taxes and fees makers, sellers, and users of agricultural equipment would prefer to avoid.

Significant advances have been made in the technology of lighting and marking on agricultural equipment operated or transported on public roadways. Various capabilities and arrangements have been prescribed for U.S. States by standards, model codes, and statutes. Today, there is no applicable Federal legislation or regulation, and statutes of States covering implements of husbandry do not require lighting and marking consistent with the identification, communication, and warning performance of lighting and marking present on new agricultural equipment.

The evolution in lighting and marking for slow-moving farm equipment on roadways has included headlights, taillights, flashing warning lights, turn signals, stoplights, warning devices such as flags, and reflectors including the special SMV (slow-moving vehicle) emblem<sup>(3)</sup>. Tracking the changes in consensus standards provides the best means to describe the variety of lighting and marking displayed on the current field and farmstead equipment fleet in use. It's the best description because the standards were and are the template manufacturers and providers of equipment followed.

The variety of lighting and marking on agricultural equipment provided since the 1950's includes a mixture of devices, configurations, and operating characteristics that conformed to the consensus standards at the time the particular lighting and marking package was offered to the public. Today, each previous package produced in conformity with those standards remains in use in roughly the quantity produced, minus attrition due to age, usage, durability, or changed practices. A small portion of equipment in use has been modified to accommodate unique local requirements, user preferences, or "improvements" (neither officially prescribed nor prohibited) advocated by groups and marketers. Neither state legislation nor otherwise has required the lighting or marking of equipment to be significantly modified or upgraded at the user level. Rarely, mass-produced presentations have required local customization, typically by dealers, to meet locally-enforced requirements. However, regulations by individual states have seldom conflicted with or impeded, and have typically not led, changes in the standards to which product providers have conformed their products. State regulations have been inconsistent, incomplete, lagging, and with a few exceptions such as the Ohio requirements for multi-wheel tractors, have not been a factor in the lighting and marking deployed on equipment at the time of original sale, resale, or in use on public roadways. Lighting and marking standards and products have changed for the better, faster, and no state's requirements have kept pace.

Federal legislation has not led to national regulation of lighting and marking for farm equipment on roadways. Despite the appeal of model legislation (e.g., UVC) benefitting uniformity and commerce among states, national model legislation for agricultural equipment lighting and marking has not provided a blueprint states have chosen to integrate into their laws. More importantly, states have not exercised independent power to compel users of older agricultural equipment on roadways to have lighting and marking maintained as produced and functioning properly, or upgraded with at least the most efficacious aspects of current production presentations. Legacy presentations on older equipment remain largely unchanged. Left under-appreciated and under-leveraged are the successful efforts by developers of standards, product providers, and others to provide compatibility between competing products, new and old equipment, and sensible international harmonization.

Tracking changes in the agricultural equipment lighting and marking presentations “as produced” in parallel with the UVC, state laws, and consensus standards reveals the varied presentations of lighting and marking that exist on today’s field inventory of agricultural equipment. Past summaries of applicable legislation in states provide snapshots in the mid-50’s, 1964, 1970, and early 1990’s.

## BRIEF AUTOMOTIVE LIGHTING HISTORY

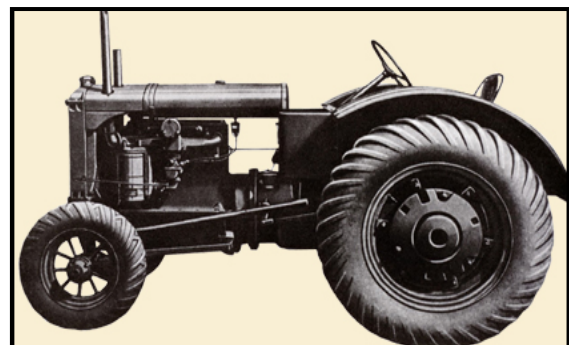
In 1887, an automobile driver failed to make his destination before nightfall. Seeking the glow of a lantern in a farmhouse window he found a helpful farmer who took his lantern in hand and walked ahead lighting the roadway home. Some owners of early cars transferred the candle lamps from their horse-drawn buggies to warn other drivers approaching, but those lamps were not bright enough to light the roadway.<sup>(4,5,6)</sup>

The primary function of headlights is to illuminate the highway to the front so the vehicle operator can see and avoid dangers that may be ahead. A secondary function is to make the vehicle more visible, especially to drivers of vehicles approaching from the front and to a lesser extent vehicles overtaking from the rear. Electric head lights and tail lamps were introduced on the Columbia Electric Car in 1898 and became a main reason for manufacturers of early motor vehicles to put batteries in these “new-fangled” buggies.<sup>(4,5,6)</sup>

Direction indicators (turn signals) are used to indicate to other road users that the operator intends to change lanes or turn. The first such indicators were hand signals. Electric turn signals were envisioned as early as 1907 (U.S. Patent #912,831). In 1925, Edgar A. Walz, Jr., secured a patent for the first modern automobile turn signal. Flashing turn signals were introduced by the Protex Safety Signal Company in 1920. Buick first offered electric turn signals as optional equipment in 1938, but only as rear flashing lights. In the 1940’s, the flashing feature came to the front of automobiles, and the application of turn signals became more widespread on automobiles of that era. Automobile regulations have required 4-way hazard flashers since the 1960’s.<sup>(4,5,6,7)</sup>

## BEGINNING AGRICULTURAL EQUIPMENT LIGHTING

Agricultural tractors and self-propelled machines that previously only traversed fields and farmyards moved onto the roadways, becoming more mobile and more feasible to operate on improving road surfaces with the transition to rubber tires in the late 1920’s and early 1930’s. The Allis-Chalmers model U built from 1929-52 (photo at right) was the first production farm tractor with low pressure rubber tires, but it was a McCormick-Deering



tractor equipped with Firestone tires that reportedly “stole the show” at the plowing match in Big Rock, IL, in 1932.<sup>(8,9)</sup>

Slow-moving farm equipment, with the attachments they carry and the implements they pull or push, safely moving and interacting with relatively higher speed motor vehicles on the road has been a goal ever since. Technical progress in lighting and marking for agricultural equipment on public roads has contributed to the successful crash prevention that can rightfully be claimed considering a greatly changed rural environment, roadway, vehicle, operator, and traffic mix in which too many crashes between farm equipment and motor vehicles continue to occur.

As with automobiles for which many components that have become necessities started as accessories<sup>(4)</sup>, so is the history of lighting and marking for agricultural equipment. Often there was a period in which a new device or operating characteristic was offered as optional equipment (“Special Equipment” below<sup>(10)</sup>), then perhaps as standard equipment with a deduct option and/or a price discount, before becoming standard in base equipment without a retail option to decline it.

**SPECIAL EQUIPMENT — when, as, and if you need it**

**A** TRACTOR buyer doesn't want to pay for accessories he doesn't need. He wants to feel free to choose accessory equipment according to the work he intends to do, the types of machines he intends to use, and his own preferences. Consequently the following equipment for "W" tractors is listed "special": pneumatic tires; tire pump; radiator shutter and heat indicator (for tractors not regularly so equipped); belt pulley; power take-off; electric lighting; electric starting; swinging drawbar; exhaust muffler; spark arrester; remote control gear shift attachment for W-9 and WD-9; wheel weights, both front and rear; and oversize lugs for steel wheels. (Note: special pistons for high-altitude operation, 5000 and 8000 feet, are optional equipment.) Regular equipment is listed on page 12.



This "remote control" gear shift attachment, available for factory or field application on W-9 and WD-9 tractors, facilitates gear shifting on these large models.



An exhaust muffler can be supplied for owners who desire quieter operation of their tractors. An extension pipe, to carry the exhaust fumes still higher above the driver's head, is also available if desired.



The swinging drawbar facilitates turning with a load, or where short turns are desired, as in disking. Drawbar shown is for W-4, W-6, and WD-6.



Standard automotive type electric lighting and starting can be supplied for all models. Provides two lights at front and one at rear. Illustration shows lights for W-4, W-6, and WD-6.

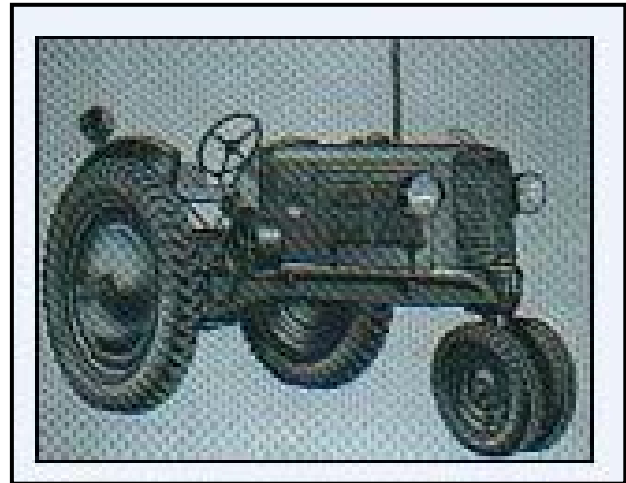
## UNIFORMITY IN CODE AND ON ROAD

Early in 1924, Secretary of Commerce Herbert Hoover with the cooperation of ten national associations interested in street and highway traffic organized a conference to make

recommendations dealing with automobile traffic safety. It had been suggested that the problem of uniformity could be settled by the federal government assuming jurisdiction through enactment of a national traffic law. That suggestion was rejected and the first conference produced only principles recommended for inclusion in state traffic laws across the nation. <sup>(11)</sup>

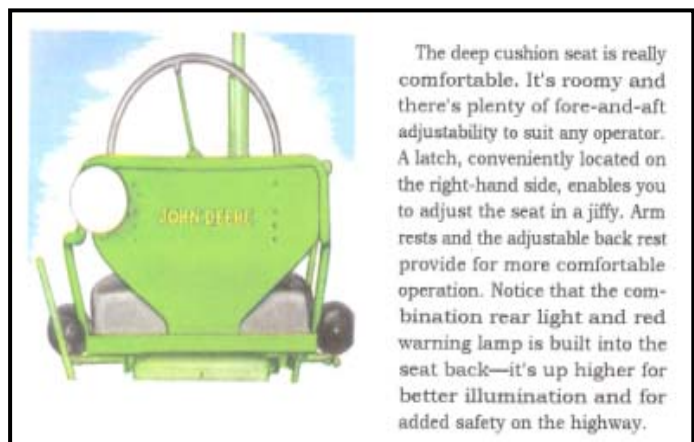
A Committee on Uniformity of Laws and Regulations was appointed a year later to draft a Uniform Vehicle Code (UVC). This committee benefitted from a tabulation of the motor vehicle laws from all the states. In July 1926, a proposed Code was adopted by the National Conference of Commissioners on Uniform State Laws, an official body of delegates appointed by governors of the states. The Code consisted of four acts: vehicle registration, antitheft, operators' and chauffeurs' licensing, and a fourth part to regulate the operation of vehicles on highways. This fourth part prescribed rules of the road, speed limits, rules against reckless driving or driving drunk, and rules governing the size, weight, and equipment of vehicles. <sup>(11)</sup>

The National Committee on Uniform Traffic Laws and Ordinances (NCUTLO) exists today as an independent, non-profit, voluntary association maintaining the UVC as a comprehensive guide and model for state vehicle and traffic laws. The UVC contains language and specifications for states to consider when formulating or revising their individual laws and regulations. <sup>(12)</sup>



There were front lights on tractors earlier, but the Oliver model 70 (photo at right) introduced in 1937 was among the earliest rubber-tired tractors with electric lighting. <sup>(8)</sup>

Prior to 1948, the UVC required only one white light, like the farmer's lantern, visible for 500 feet at night. The expectation for headlights on tractors and self-propelled machines was incorporated into the UVC in 1948. Typical tractors of the 1950's were equipped with a headlight and a white or white/red combination taillight (photo at right) as on the John Deere model 50 and model 60 tractors. <sup>(13)</sup> State requirements at the time "varied all over the map", and in some states one could drive a tractor at night on the public roadway with practically no lighting.



In the 1948-1956 editions of the Code, a headlamp was required only on equipment having an electric lighting system although the single white light requirement remained applicable for

vehicles without an electric system as well. In 1962 the Code was amended to require two headlamps on any agricultural tractor or self-propelled machine on the roadway at night. The 1968-1970 period UVC proposed that all agricultural tractors and self-propelled machines on roadways at night have at least two headlights, but it did not require front lights on self-propelled farm equipment or a light at the left extremity of combinations of equipment.<sup>(14)</sup>

All editions of the UVC from 1926 through 1970 called for at least one red light visible to the rear of any tractor or self-propelled machine operated on the highway at night. Two editions (1954 and 1956) required two red lights if there were no reflectors present. One edition (1962) required two red taillights.<sup>(14)</sup>

John Deere model 50, 60, and 70 tractors offered a new feature in the spring of 1954: a two-contact electrical outlet under the operator's seat on the side of the battery box (LH Gay, personal communication, 12 December 2007). Illustrated in advertising for John Deere model 520, 620, and 720 tractors from 1956 (right and below), this outlet provided a means to power auxiliary lights and extremity warning lamps on implements. This advertising excerpt also shows a swing-away arm on the tractor with a warning lamp to forewarn motorists and indicate the tractor's left extremity.<sup>(15)</sup>



Prior to 1952, the Code did not address lighting requirements for a towed implement, or a combination such as a tractor with a towed implement. As previously noted, from 1926 until 1952 the Code required one red taillight or lantern visible to the rear at night. From 1952 until 1968 the Code required a light on the left side indicating to the front and to the rear the extreme left projection of equipment. This requirement was deleted in 1968 when the requirement for a front left reflector was added.

The 1952 Code also required two red tail lights or two red reflectors, and the 1962 Code required 2 lights and 2 reflectors on the towed unit. The 1954 and 1956 editions of the UVC

differed according to whether the combination had an electric lighting system. If it had an electrical system, the 1954 Code required two taillights or one light and two reflectors, which in 1956 was changed to two taillights or two reflectors. If it did not have an electrical system, then two taillights or one taillight and two reflectors were prescribed. The 1962 Code prescribed two red lights and two red reflectors on the towed implement.<sup>(14)</sup>

McFarland based on information gathered in the summer of 1964 documented agricultural equipment lighting and marking requirements in state laws for the National Safety Council.<sup>(16)</sup> Twenty-five states required two headlights on agricultural tractors and self-propelled machines. All other states, except one, required at least one headlight. The majority of states required at least one taillight on tractors, self-propelled agricultural equipment, and implements, while others specified two. One state did not require any taillight. Pennsylvania and Ohio required flashing red taillights. Indiana and Michigan permitted their use. Illinois and Indiana allowed them as an alternative to warning flags, which were otherwise required in those two states.

The 1962 edition of the UVC had included several recommendations covering headlights, taillights, reflectors, minimum visible distance requirements, and the positioning of lamps and reflectors to show the width of farm equipment. Nevertheless, farm equipment lighting sections of the UVC underwent another extensive set of changes before the 1968 edition emerged.

The 1968 UVC included provisions for all agricultural tractors and self-propelled machines operated on roadways at night to have at least two headlights and required all tractors and self-propelled machines to be equipped with at least one red taillight and two red reflectors.<sup>(14)</sup> Also beginning in 1968, the UVC required every agricultural tractor and self-propelled machine to be equipped with hazard warning lights, sometimes called 4-way flashers, to be displayed whenever the tractor or equipment was on the roadway since increasing daytime conspicuity is, in part, also a capability of the simultaneously flashing hazard warning lights.

According to NCUTLO, significant advances had been made in the technology of agricultural equipment lighting by 1970 and they had been considered in revisions of the UVC lighting requirements for agricultural tractors, self-propelled machines, and implement combinations.<sup>(14)</sup> Unfortunately, the laws in a great number of states did not followed suit. One-third still required only minimal lighting devices considered practicable decades earlier. Another third retained differences based on the presence or absence of an electrical lighting system, an accommodation removed from the UVC nearly a decade earlier. At the time of the US Secretary of Transportation's report to Congress, entitled "Agricultural Tractor Safety on Public Roads and Farms", January 1971, only one state had laws conforming in all respects with the UVC and only twelve were in substantial agreement with the UVC with regard to agricultural tractors and self-propelled machines.

The laws of 34 states at the beginning of 1971 required headlights on some or all tractors and self-propelled machines and the laws of 40 states required "front lights" on some or all such equipment. (Recall that front lights were any lamp other than a headlamp emitting light visible from the front to notify other oncoming traffic of the presence of the farm vehicle and were frequently required by state laws to be positioned near the leftmost extremity of the farm vehicle or combination.) Seventeen of these 40 states required only front lights and did not require

headlights on any farm equipment. Eleven states required headlights per the UVC on all agricultural tractors and self-propelled machines. Nine required headlights on all agricultural tractors and self-propelled machines with electrical lighting systems and a front light on all such equipment lacking an electrical lighting system. Six required headlights on tractors but not on other self-propelled machines, while six required them on self-propelled machines and not on tractors. Four of the aforementioned eleven states additionally required a front light on some agricultural equipment to indicate its left extremity.

Only one state required simultaneously-flashing hazard warning lights on all agricultural tractors and self-propelled machines at the beginning of 1971. Only two other states required any flashing lights on tractors or implements of husbandry. One state required either an amber flashing light or the SMV emblem. Four states expressly permitted the use of flashing lights on certain farm equipment but did not require it. No information was available at that time on the enactment of any laws regarding turn signals for tractors operating on the public roadways.

Twelve states were in substantial agreement with the Code at the end of 1970 with regard to taillights and rear reflectors. Another nine required one light and two reflectors, but not on all such equipment. Laws in 23 states required one light visible to the rear. Seven states did not require at least one rear light on all farm tractors and self-propelled machines.

Seven states required both taillights and reflectors on all implements towed on a highway at night. Eleven required two taillights, or one taillight and two red reflectors, on all combinations on the highway at night. One state required two taillights. Twenty-one required one light at the rear. Five required only reflectors, and the remaining five did not set any taillight or reflector requirements for towed implements in combination, or for the combination as an overall unit.

Jumping forward in time to the early 1990's, another Ohio State University study found thirteen states required only one headlight while only one of those states required a lamp or a reflector placed as far left as practicable.<sup>(4)</sup> Thirty-six states required two head lamps. Nine of the states requiring two headlamps had provisions requiring only one lamp for tractors without electrical systems. Forty-eight states did not require headlamp use during daylight, and most states required headlamp use from one-half hour after sunset to one-half hour before sunrise.

All states had requirements for taillights, except one, and ninety-four percent of states required these taillights to be red in the early 1990's. Two made no mention of a specific color. One state allowed white, red, or a combination white/red taillight. Only one taillight was required in thirty-five states. Of these thirty-five states, four called for one lamp or reflector placed as far left as practicable. One required only one taillight on tractors but two on self-propelled machines. Fourteen states required two taillights on tractors and self-propelled machines. Three of these fourteen states allowed the use of two reflectors and one taillight instead of two taillights. Two of fourteen states required only one taillight and two reflectors when the equipment had no electrical system.

Amber flashing warning lamps are often used as turn signals. Forty-nine states did not require turn signals on tractors and self-propelled machines. Eleven states required amber flashing lamps on tractors and self-propelled machines. Thirty states did not require them. Three states

did not permit the use of amber flashers. Six states were silent on the subject of amber flashers.

Eight states had no requirement for taillights on towed agricultural implements. Thirty states expected them to display at least one taillight. Of these thirty, one required no taillight on the implement when the towing unit displayed an SMV emblem. Four states required one light or a reflector placed as far left as practicable. The remaining fifteen states required taillights in various combinations with reflectors and/or the SMV emblem.

Thirty-five states did not require amber flashing lamps on towed implements, three did not permit them. Five states did not mention amber flashers, and seven required their use. Three of those seven required their use only when the flashers of the towing or propelling unit were obscured. Forty-four states did not require turn signals on towed implements and six states had no relevant provisions in their regulations.

The 2000 edition of the NCUTLO UVC offers that, after a specified date left to each state's discretion, every new tractor and self-propelled machine be equipped with at least two headlights, at least one red rear light mounted as far left as practicable, and two red rear reflectors.<sup>(17)</sup>

UVC 2000 calls for every agricultural tractor and self-propelled machine to be fitted with hazard warning lights visible to the front and to the rear, whenever it's on a roadway, to warn operators of other vehicles about the presence of a special traffic hazard requiring unusual care. Moreover, every such vehicle is to be equipped with hazard warning lights required for that vehicle by applicable standards of the US Department of Transportation at the time of its manufacture. However, to this author's knowledge no such US Department of Transportation standards have been promulgated.

For every combination of an agricultural tractor and towed implement according to UVC 2000, the tractor is to be equipped as described in the preceding two paragraphs and the towed implement equipped as follows. If the towed unit extends over four feet to the rear of the tractor or obscures any light, the implement shall be equipped with at least one red rear light mounted as far left as practicable and at least two red rear reflectors. If the towed implement extends over four feet to the left of the tractor's centerline, the implement shall be equipped with an amber reflector to the front as far left as practicable.

If the towed implement or its load obscures either of the flashing warning lights of the tractor, the towed implement shall be equipped with hazard warning lights as prescribed for the tractor along with two red rear reflectors positioned to delineate the combination's extremes of width. So, in some instances reflectors are substituted for lights.

## VOLUNTARY CONSENSUS STANDARDS

ASABE, the American Society of Agricultural and Biological Engineers (formerly American Society of Agricultural Engineers, ASAE), is a technical society and the recognized standards

developing organization for agricultural field and farmstead equipment standards in North America. ASABE standards are consensus documents developed and adopted to meet standardization needs within the scope of the Society: principally, agricultural field equipment, farmstead equipment, structures, soil and water resource management, turf and landscape equipment, forest engineering, food and process engineering, electric power applications, plant and animal environments, and waste management.<sup>(18)</sup>

It is these standards to which agricultural equipment makers and providers conformed their products and presentations of lighting and marking and therefore provides a means to describe the lighting and marking actually deployed on farm equipment in use since at least the middle 1950's. ASABE standards, engineering practices, and data are informational and advisory only. Use of these standards by anyone engaged in industry or trade is entirely voluntary and conformity does not ensure compliance with applicable ordinances, laws, and/or regulations. What follows are this author's interpretations of relevant ASABE standards for the lighting of agricultural equipment over the past half century.

There were various forms and forums, ad hoc recommendations and guidance, for agricultural equipment lighting prior to the 1950's (S Cedarquist, private conversation, December 2007). The first published compendium of ASAE standards was in the *Agricultural Engineers Yearbook* in 1954.<sup>(19)</sup> It included a standard on "Safety Lighting for Combinations of Farm Tractors and Implements". The preface to that standard states:

"Act V, Section 137c, Uniform Act Regulating Traffic on Highways, revised and approved by National Committee on Uniform Traffic Laws and Ordinances, 1952, established regulations for safety lighting of farm tractors and implements when transported on the highway at night. Specifications essential to conformity with these regulations were accordingly developed by the Advisory Engineering Committee of the Farm Equipment Institute, and were adopted February, 1954, as an official standard of the American Society of Agricultural Engineers."

Note: The Farm Equipment Institute was the former name of the industry trade association for major manufacturers of farm equipment. Its name, scope, and functions have changed over time but somewhat similar work continues within the current Association of Equipment Manufacturers (AEM).<sup>(20)</sup>

The 1954 ASAE standard called for tractor manufacturers to provide a 2-pronged electrical outlet. This outlet provided power to a safety lamp, showing red to the rear and amber to the front, which tractor manufacturers were to "make available". It called for a means for the lamp to be mounted on the tractor, or optionally at the left extremity of the towed implement and be energized through a 22-foot electrical cable running from the 2-pronged outlet on the tractor. In addition, towed implement providers were to make available either two taillights or two reflectors showing red to the rear and indicating as nearly as practicable the extreme left- and right-rear extremities of the towed implement. If implements mounted on the tractor obscured the tractor's lighting, that lighting was to be moved or reproduced on the implement. Mounted implements extending more than 4-feet to the left of the tractor's centerline were required to have reflectors or an additional taillight. In addition, providers of self-propelled agriculture equipment were to

make available lighting and marking consistent with that for tractors and tractor-implement combinations.

A standard for self-powered, electric warning lights was published in the 1961 edition of ASAE *Agricultural Engineers Yearbook*.<sup>(21)</sup> It specified tests and photometric performance for a lamp, whether it flashed or “burned” steady, to forewarn oncoming motorists of the presence of farm equipment on the roadway. This lamp used the same mounting bracket as the safety lamp on the tractor or implement. It showed red to the rear and, if visible from the front, was to appear as amber.

A new standard for lighting and marking of agricultural tractors, self-propelled machines, implements, and implements in combination with tractors or self-propelled machines was published as “*ASAE Standard S279, Lighting and Marking of Farm Equipment on Public Roads*” in the 1965 edition of *Agricultural Engineers Yearbook*.<sup>(22)</sup> It is instructive to consider the purposes for which this edition of the standard was aimed:

- “1.1 To provide for lighting and marking of farm equipment for the purpose of promoting safety for the operator of the equipment and for the operators of other vehicles whenever such farm equipment is in operation, or is being transported, on a public road;
- 1.2 To provide manufacturers with a suitable guide for uniform practice in the industry; and
- 1.3 To assist regulatory bodies and educational groups in formulating uniform regulations and programs governing the operation or transport of farm equipment on public roads.”

The ASAE S279 standard (1965 edition) distinguished between lighting and marking for daytime versus nighttime transport on roadways, as well as between what was required for equipment with or without electric lighting systems. Daytime transport of farm equipment on roads required equipment with electric lighting systems to have a safety lamp showing red to the rear and amber to the front mounted at the left rear of tractors, self-propelled machines, and mounted or towed implements. Equipment without an electric lighting system was to display a warning flag or other generally accepted emblem during daytime transport.

In addition to making the safety lamp available (including mountings, connectors, cable and cable stowage means), tractors, self-propelled equipment, and implements in combination with a tractor or self-propelled machine on the road at night were to have at least two headlights, at least one taillight, provisions for the safety light connection, and the ability to switch off rear work lights or convert them to red lights during road transport. If the mounted or towed implement obscured the safety lamp or extended over 4-feet left of the towing unit centerline or extended over 15-feet rearward from the drawbar hitch point, the safety lamp was to be positioned at the rear left of the implement. Manufacturers of tractors and self-propelled equipment were also to make an extension cord available to jumper around the first implement to the second for implements in tandem or wagon trains.

The 1970 edition of the *Agricultural Engineers Yearbook* carried a revision to the ASAE S279 standard entitled “Lighting and Marking of Agricultural Equipment and Industrial Equipment on Highways”.<sup>(23)</sup> “Requirements” for the safety light (along with its socket, cable, and bracket) were discontinued, although the supporting standards for them were still published. Other changes called for adding at least two amber flashing warning lamps on tractors and self-propelled equipment. This addition of amber flashing warning lamps continued the treatment of slow-moving farm equipment on roadways as if they were a stationary barrier and, when energized, these warning lights provided a forewarning of such hazards ahead requiring special precautions by motorists, day or night.

The amber flashing warning lights on tractors and self-propelled equipment prescribed in the 1970 edition of the ASAE S279 standard were adapted to accommodate use as turn indicators in the 1972 edition.<sup>(24)</sup> The flashing lamp(s) in the direction opposite the direction of turn were to become steady burning until the turn signal was cancelled. This occurred at a time of strong demand for new and improved operator enclosures on tractors and self-propelled machines, which made obvious the need for a turn signal control, and problematic continued reliance on hand signaling (R Straszheim, private conversation, 5 February 2008).

The ability to mimic the amber flashing warning lamps of tractors and self-propelled machines on implements was prescribed in the March 1974 revision (1974 edition) of ASAE standard S279.<sup>(25)</sup> It called for a new, seven-pin connector to be “made available” (similar conceptually to the two-pin connector of the safety lamp era), with half the connector on the towing unit and the mating half on the implement, for those instances when the towed or mounted implement obscured the effective illumination of any flashing warning lamp on the towing unit. By fall 1975 at least one manufacturer had made this 7-pin connector available as a field installed option on agricultural tractors (RD Straszheim, personal conversation, 5 February 2008). The flashing warning lights on implements therefore had wiring capable of supporting their use as turn indicators, flashing in unison and synchronized with the warning lamps of the tractor. In addition, this revision of the standard required flashing lamps in the direction of the turn to increase in flashing rate at least 20 flashes per minute above their nominal rate to better communicate an intention to turn.

Changes to the 1974 edition published in *ASAE Standards* (1982 edition) added turn signals and taillights to flashing warning lamps which, if obscured by the implement, required lighting at the rear extremities of the implement.<sup>(26)</sup> In particular, if any of the flashing warning lamps and turn signals, and / or taillights of the propelling unit were obscured by the implement at least two amber flashing warning lights and, with this revision, at least one red tail lamp were to be prominently displayed.

ASAE standard S279 was again revised in April 1988.<sup>(27)</sup> Machines over 13-feet wide were to have at least two amber flashing warning lamps to indicate their left and right extremities. These lights could be in place of or in addition to the amber flashing lamps specified for tractors and self-propelled machines. In addition, rather than simply permitting them to be used as turn indicators, this edition of the standard stated that amber flashing warning lamps were to be used

whenever turn indicators were provided. Also with this revision implements 1) over 13-foot wide or extending over 6.6-feet left or right of the centerline of the prime mover and beyond its left or right extremities, or 2) extending more than 33-feet to the rear of the hitch point, were to have at least two amber flashing lamps (except in the case of an offset implement when only one such lamp was needed).

The 1998 revision of S279 in *ASAE Standards 1999*...informed by results from additional research at The Ohio State University...rewrote much of the ASAE S279 standard.<sup>(28)</sup> Provisions were added for retroreflective and fluorescent (conspicuity-enhancing) materials and their use, requiring two taillights, and calling for turn indicators to be provided. Taillights were added to the template for lighting of wide and long equipment.

ASAE standard S279 OCT98 specified two red taillights in addition to at least two headlamps, with at least two amber flashing warning lamps visible front and rear to mark the left and right extremities of tractors and self-propelled machines. Turn signals were to be provided, their treatment no longer prefaced with the language of optional equipment, e.g., “if or when provided”. And, the turn signaling characteristic of steady burning lamps on the side away from the turn was applied to taillights since more than one taillight was now prescribed.

The principle that lighting on a towing unit obscured by the implement required provisioning of that lighting on the implement continued. If taillights are obscured, a symmetrically mounted pair of them, each at least 2-feet and no more than 5-feet from the centerline at the rear of the towed implement, was specified. If the rear amber flashing lamps were obscured, at least two were to be added, one to mark the rear left and one to mark the rear right. If rear turn indicators were obscured, their replacement was positioned and functioned like those on the towing unit. These same principles were at this time also applied to forward facing lamps on implements mounted to the front of the prime mover, such as front-mounted implements on tractors and headers on combines.

Separate from the question of obscured lighting, wide (over 12-feet), offset (over 6-feet left or right), and long (over 25-feet from the hitch point) equipment needed at least two amber flashing warning lights, two red taillights, and turn indication capabilities according to ASAE standard S279 OCT98.

Adjustments in ASAE standard S279 published in “*ASAE Standards 2001*” allowed taillights and turn indicators to be positioned no more than 5-feet left or right of centerline, except on wide implements where they did not obscure the taillights of the propelling unit and could be spaced further apart.<sup>(29)</sup> In addition, the lamp on the side opposite the turn was permitted to remain off or on, become brighter, but not allowed to flash. And, equipment very narrow at the rear and equipped with only one red tail light was not expected to have turn indicator capabilities.

Finally, the current version American National Standards Institute (the official US body in international standardization work) ANSI/ASAE Standard S279.13 “Lighting and Marking of Agricultural Equipment on Highways (DEC2005)” incorporates provisions for at least two red, rear-facing stop lamps on machines designed for travel at speeds over 25 mph and optionally for slower transport design speeds.<sup>(30)</sup> These stop lamps are illuminated by braking control

activation and deceleration rate of the equipment. Stop lamps may be combined with tail lamps or may be in addition to them, in which case they are placed at the left and right rear extremities and, if used to meet additional turn indicator provisions, must perform accordingly. However, if the machine is less than 4-feet wide, only one stop lamp is required. Provisions for lighting obscured by implements are only applied to stop lights for semi-mounted or towed equipment designed for speeds over 25 mph, and to all fully mounted implements.

## SUMMARY

The lighting and marking displays a motorist can expect to see on agricultural equipment in transport on America's rural roadways include those conforming to the current standard, those conforming to standards of the past, allowable variations of current and past standards, equipment without any lighting or marking, arrangements conforming to special requirements enforced within local jurisdictions, and customized displays allowed by law as well as a few that should not be.

The motoring public approaching oncoming, modern agricultural equipment today on a rural roadway at night should typically see its white headlamps and amber flashing warning lamps. If it is wide, additional flashing amber lamps should be visible at the left and right extremities. If it is a wide tractor pushing or pulling a wide implement, or a self-propelled machine with a wide header, additional flashing amber lamps can be seen at the extremities of the implement or header. When the oncoming equipment indicates a turn, all flashing lamps in the direction of the turn start to flash at an increased rate and those on the side away from the turn burn steadily. If its lights are off, white or amber retro-reflective reflectors may be visible near the extreme width of the prime mover and/or the implement and may also be visible at approximately 5-foot intervals between for wide machines.

Overtaking modern agricultural equipment going in the same direction at night, a motorist may see red tail lamps typically less than 10-feet apart and centered on the back of the machine as well as amber flashing warning lamps. If the equipment is wide or is towing a wide implement, additional amber flashing warning lights indicate the extremes of the towing unit's width and/or the extremities of the implement. In some instances a pair of red tail lamps and the flashing amber warning lamps at the extremities will be visible. Other times, two or more of the flashing amber warning lamps on the towing unit will also be visible and, sometimes, the towing unit taillights will be, too. All flashing lamps flash in unison and are synchronized so that all on the turn side flash in unison at an increased rate when the turn signal is actuated and all on the side away from the turn burn steady, stay off, or increase in intensity. If lights are off, red retro-reflective reflectors may be visible near the extreme width of the prime mover and or on the implement and may also be visible at approximately 5-foot intervals between for wide machines. In addition, the SMV with improved conspicuity materials or old and faded may be visible at the rear of the prime mover and/or the attachment, implement, or trailer.

The displays motorists can expect to encounter in the daytime include those described in the first paragraph of this section, but more frequently they will encounter equipment without lighting

which is both conspicuous and forewarning, coming or going. In addition, the fluorescent orange center of any visible SMV and the fluorescent orange extremity reflectors should be visible.

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