

OCCUPATIONAL SAFETY AND HEALTH
STANDARD BOARD

PETITION FILE NO. 571

BOARD STAFF EVALUATION

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INTRODUCTION

Petition File No. 571 (Petition) was submitted by Michael Pankonin on behalf of the Association of Equipment Manufacturers (Petitioner) on November 26, 2018. The Petition seeks to amend Title 8, General Industry Safety Orders, Section 3441(b) to allow the use of highly automated agricultural equipment and autonomous agricultural equipment.

REQUESTED ACTION

The Petitioner requests the Board amend Section 3441(b) by adding the following language:

“Highly automated agricultural equipment and autonomous agricultural equipment may be operated by an operator not on the equipment provided that it is used in accordance with manufacturers’ instructions and guidance.”

PETITIONER’S ASSERTIONS

The Petitioner states “there has been a lot of design effort directed toward developing highly automated agricultural equipment and autonomous agricultural equipment.” He further states that because of the many applications of the equipment, the equipment will need to operate in close proximity to humans. Petitioner asserts that Section 3441(b), “as currently published, will prohibit [the use of such equipment] as intended and severely limit its functionality.”

STAFF EVALUATION

The Petitioner is concerned that subsection 3441(b) will hinder the production and use of modern driverless technologies being developed for agricultural use. The subsection reads as follows:

3441(b) All self-propelled equipment shall, when under its own power and in motion, have an operator stationed at the vehicular controls. This shall not prohibit the operator occupying or being stationed at a location on the vehicle other than the normal driving position or cab if controls for starting, accelerating, decelerating and stopping are provided adjacent and convenient to the alternate position. If the machine requires steering other than ground or furrow steering or operates at ground speeds in excess of two miles per hour, steering controls shall also be provided at the alternate location. Seedling planters and other similar equipment traveling at a speed of two miles an hour or less where a control that will immediately stop the machine is located at the operator's work station will satisfy this requirement.

(1) Furrow guided self-propelled mobile equipment may be operated by an operator not on the equipment provided that all of the following are complied with:

(A) The operator has a good view of the course of travel of the equipment and any employees in the immediate vicinity.

(B) The steering controls, when provided, and the brake and throttle controls are extended within easy reach of the operator's station.

(C) The operator is not over 10 feet away from such controls and does not have to climb over or onto the equipment or other obstacles to operate the controls.

(D) The equipment is not traveling at over two miles per hour ground speed.

One challenge faced by Highly Automated Agricultural Machines (HAAM) and their regulation under Cal/OSHA standards is that HAAM can come in almost limitless forms. Some HAAM is truly autonomous (e.g. a robotic milker on a dairy that a milk cow can access on demand¹), while others have the option of being autonomous for some tasks and then remote controlled or manually operated for others (e.g. a grain cart that works autonomously to collect harvested grain from a working combine and then returns to a staging area for a worker to offload the grain for transport^{2,3}).

Although some types of HAAM may be regulated by certain subsections in Title 8, in many cases there will be no directly applicable standard to the equipment and the function it is performing. For instance, another example of HAAM is an orchard sprayer manufactured in Kingsburg, CA. The Global Unmanned Spray System, or GUSS⁴, operates using GPS, onboard sensors, and software to navigate an orchard while applying pesticides and other agricultural products. Although the GUSS is driverless, a remote operator supervises a fleet of up to ten unmanned vehicles using onboard cameras.

Applying subsection 3441(b) to the GUSS could present issues in that there are no onboard “vehicular controls,” nor is there a “normal driving position.” Also unclear is how subsection 3441(b) and other regulations would apply to a remote operator.

Because of technological advancements in the field of HAAM, regulating the GUSS and similar equipment may create challenges for enforcement personnel due to the variety of ways the technology can appear. Similarly, it can be anticipated that employers will experience difficulties in their efforts to comply with the mismatched regulations.

¹ <https://www.nytimes.com/2014/04/23/nyregion/with-farm-robotics-the-cows-decide-when-its-milking-time.html>. Accessed 1/31/19.

² <https://www.seedotrun.com/faq.php>. Accessed 1/31/19.

³ <https://www.youtube.com/watch?v=YFy6ZAJbeew&index=2&list=PL4A9EEE75D109BD18>. Accessed 1/31/19.

⁴ <http://gussag.com/>. Accessed 1/31/19.

Because the technology is relatively new, accident data and reliability statistics for the built-in employee protections are not readily available. Representatives from the Division of Occupational Safety and Health (Division), Board staff, and members of the NIOSH Division of Safety Research's Center for Occupational Robotics Research, convened a conference call to discuss such issues as they relate to autonomous vehicles in agriculture.

Dawn Castillo, Director, and Hongwei Hsiao, Branch Chief, Division of Safety Research, and Brad Husberg, Director of the NIOSH Office of Agriculture Safety and Health, explained that the driverless technology used in agriculture is the same technology used in transportation, mining, and construction. They said that NIOSH is funding much of the research in the field, but is not currently performing any internally. The trio suggested reaching out to universities, such as UC Davis, and private companies, such as John Deere, for further guidance should California decide to draft a regulation.

When asked about using consensus standards as a basis for a regulation, Ms. Castillo cautioned that field testing often showed deficiencies in the design of a machine. She suggested that testing be done by more than the manufacturer alone. She also recommended that the hazards posed by employee exposure and the operation of the equipment in an uncontrolled environment be addressed in any proposed regulation.

Relevant Standards

Although HAAM is used in many countries and states, a widely adopted consensus standard or a detailed set of regulations for employee protection are not yet available. Manufacturers may develop safeguards into their HAAM based upon field test results, industry needs, and lessons learned from the transportation sector, but the protections are not necessarily uniform on agricultural equipment from different manufacturers.

Federal Standards

Federal agricultural regulations include general requirements for protecting employees from hazards created by moving machinery parts, as well as general equipment safety training requirements, but do not specifically address HAAM.

California Standards

Title 8, subsection 3441(b) as described above along with other generic guarding and training standards exist, but none specifically address HAAM.

The California Department of Motor Vehicles (DMV) has requirements for the operation of autonomous vehicles on public roads, but does not address HAAM. The DMV regulations may serve as a helpful reference should an advisory committee be convened or a regulation promulgated.

Consensus Standards

ISO 18497:2018 “Agricultural machinery and tractors—Safety of highly automated agricultural machines—Principles for design” is a recently published performance standard that lays out guidelines for the manufacture of HAAM and which could be applied to a wide variety of equipment. The standard does not provide prescriptive requirements or specific benchmarks, but instead provides general principles to address the potential hazards.

For instance, in Section 4.2 “Principles for Protection,” the standard reads:

For ensuring an appropriate level of safety:

- *the HAAM shall be provided with a perception system capable of detecting and locating persons or other obstacles relative to the machine;*
- *the HAAM shall be provided with a perception system capable of locating and positioning the HAAM as required for the operations involved while preventing unintended excursions beyond the boundary of the working area;*
- *before each movement of the HAAM, it shall be ensured, by the safeguarding system, that there is no obstacle in the hazard zone;*
- *while performing highly automated operations, the HAAM shall, when an obstacle is detected in or enters the hazard zone, give an audible or visual alarm and enter its defined safe state;*
- *the HAAM shall be provided with the means to enable a local or remote operator to stop or start highly automated operation;*
- *the HAAM shall allow adequate supervision by a local or remote operator.*

Definitions are provided as well as a comprehensive list of additional requirements for the safe operation of the HAAM.

Various other consensus standards exist which could be helpful in crafting a standard to regulate HAAM, including ISO/TR 22100-4, “Safety of machinery – Relationship with ISO 12100 – Part 4: Guidance to machinery manufacturers for consideration of related IT-security (cyber security) aspects.” According to the ISO website, the cyber security standard is designed to help machinery manufacturers identify and address IT security threats that can impact the safety of their product⁵ (e.g. unauthorized activation or hacking of HAAM).

Other Standards, Guidelines, Codes

Much of the current research into autonomous machines is being done in the field of transportation. Ontario, Canada, and other jurisdictions, for example, have guidelines for Automated Driving Systems, but do not include off road vehicles or agricultural equipment. A search for requirements in other states that would regulate HAAM did not produce any results.

Position of Division

The Division evaluation dated March 20, 2019, recommends denial of the Petitioner’s request, citing a lack of sufficient data demonstrating the safety of HAAM. The Division evaluation states that collision prevention technology on HAAM “has not yet been perfected and will not prevent injuries to employees working in proximity to [HAAM] under all likely working conditions.”

Analysis

According to the GUSS website, safety features for its orchard sprayer include a laser system that stops the vehicle when an obstacle is detected in its path. The vehicle also has a touch sensitive bumper that will shut down operation if pushed. Using the GUSS software, a virtual fence is added around the field’s perimeter that is designed to disable the sprayer if crossed. Additionally, the remote operator can immediately shut down the vehicle if he/she observes a hazard via the onboard cameras.

The virtual fence, obstacle detection, and remote shut down features appear on many examples of HAAM. Another common feature of many machines is the ability to supervise the equipment remotely via onboard cameras. Much of the equipment also includes “black box” technology, which records data that can be used to investigate accidents should they occur.

⁵ <https://www.iso.org/news/ref2365.html> Accessed 1/30/19.

In spite of the many safety features built in to autonomous equipment, accidents in the field of transportation indicate that further refinement of the technology is necessary⁶. Additionally, solely relying on a manufacturer's operating manual for employee protections may not guarantee adequate protection of California workers. Therefore, a discussion on the viability of autonomous machines in agriculture has merit and should occur to ensure that employee protections are in place before the inevitable expansion of the technology. Although the technology is in limited use in California today, the Petitioner expects that it will become much more prevalent in the near future.

The advisory committee discussion should include:

- 1) Definitions for highly automated and autonomous equipment.
- 2) Protections for employees working both directly with and in the vicinity of HAAM. The committee should consider including the most protective requirements for those workers who will work directly with the HAAM.
- 3) Where HAAM is used in isolation, prevention of unintentional employee exposure.
- 4) Any special training requirements for working around HAAM that are not included in existing regulations.
- 5) Suitability of ISO 18497:2018 as a consensus standard for designing HAAM that will operate near employees, and/or any other standards regarding employee protections that should be included in HAAM operating in California.
- 6) Means to ensure that HAAM safety features will function as intended in real-world conditions.
- 7) Means to prevent unauthorized use or hacking of HAAM.
- 8) The need for, or benefits of, special procedures or requirements for reporting employee injuries or illnesses resulting from exposure to HAAM.

⁶ <https://www.digitaltrends.com/cool-tech/most-significant-self-driving-car-crashes/>. Access 2/4/2019.

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STAFF RECOMMENDATION

Board staff recommends Petition File No. 571 be Conditionally Granted, such that Board staff is directed to convene a representative advisory committee to discuss the issues identified above. The Petitioner should be extended an invitation to participate in the advisory committee deliberations.