SAE International™ SURFACE VEHICLE STANDARD

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Industrial Flail Mowers and Power Rakes

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1. ***Scope***—The guidelines for operator and bystander protection in this recommended practice apply to towed, semimounted or mounted flail mowers and flail power rakes when powered by a propelling tractor or machine of at least 15 kw (20 hp), intended for marketing as industrial mowing equipment and designed for cutting grass and other growth in public use areas such as parks, cemeteries and along roadways and highways.

The use of the word "industrial" is not to be confused with "in-plant industrial equipment".

This document does not apply to:

1. Turf care equipment primarily designed for personal use, consumption or enjoyment of a consumer in or around a permanent or temporary household or residence.
2. Machines designed primarily for agricultural purposes but which may be used for industrial use.
3. Self powered or self propelled mowers or mowing machines.

Where other standards are referenced, such reference applies only to the document identified, not revisions thereof.

1.1 **Purpose**—To establish guidelines for operator and bystander protection for flail mowers and flail power rakes whose intended use falls within the scope of this document.

2. ***References***

2.1 **Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the lastest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J115—Safety Signs (ASAE S441)
SAE J208—Safety for AGricultural Equipment (ASAE S318.7)
SAE J715—Three-Point Lift Free-Link Attachment of Implements, Ag Wheeled (ASAE S217.10)
SAE J898—Control Locations for Off-Road Work Machines
SAE J909—Three-Point Hitch Implement Quick Attaching Coupler, Ag Tractors (ASAE S278.6)
SAE J920—Technical Publications for Agricultural Equipment (ASAE EP363)
SAE J1150—Terminology for Ag Equipment
SAE J1500—Universal Symbols for Operator Controls

3. ***Definitions***—(See also SAE J1150):

3.1 **Flail Mower**—A mower that cuts by impact with a multiplicity of free-swinging knives that rotate about an axis parallel to the cutting plane.

3.1.1 FLAIL POWER RAKE—A power rake that raises thatch or debris from the turf by a multiplicity of free-swinging knives that rotate about an axis parallel to the cutting plane.

3.2 Arm Type Flail Mower—Flail mowers which are intended to be used frequently with the cutter portion not adjacent or parallel to the ground.

3.3 Functional Component—A working mechanism of an attachment or implement designed to perform a specific task such as the cutting blade of a flail mower.

3.4 Guarded by Location—A potential hazard is so guarded when it is covered by other parts or components of the machine, or because of its remote location, inadvertent contact is minimized during normal operation or servicing.

3.5 Inadvertent Contact—Contact between a person and a machinery hazard, or other type of hazard, resulting from the person's unintentional actions during normal operation.

3.6 Machinery Hazard—A source of potential injury created by machinery which can cause serious injury upon contact or by entanglement of personal apparel. This includes, but is not limited to, the pinch points of power driven gears, run-on points of belts and chains, and projections on rotating parts.

3.7 Normal Operating Position—The space within operator zone occupied by the operator while operating mower. The operator is sitting on the seat with hands on the steering controls and feet on controls or areas provided for foot placement. For Operator Zone, see SAE J898.

3.8 Power Take-Off (PTO)—An external shaft on the rear of a tractor to provide rotational power to implements. (SAE J208 JUL83)

3.9 Implement Input Drive Line (IID)—Two universal joints and their connecting member(s) and fastening means for transmitting rotational power from the tractor PTO to the imiplement input connection. A double Cardan, constant velocity joint is considered a single joint. The IID also includes integral shielding where provided. Reference SAE J208 JUL83.

3.10 Label—A durable label used as a safety sign or for instruction or identification and that shall meet or exceed the requirements of 4.2.3.

3.11 Propelling Machine—A tractor or self-propelled machine.

3.12 Standard Test Operator—A person weighing 95 ±5 kg (209 ±11 lb) and standing 188 ±5 cm (74 ±2 in) tall.

3.13 Shield (Or Guard)—A barrier which minimizes inadvertent personal contact with hazards.

4. General Requirements

4.1 Guarding and Shielding

4.1.1 Inadvertent contact with hazards shall be minimized during normal mounting, starting, operating, or dismounting the equipment by guarding and shielding.

4.1.2 The following are some of the potential hazard areas:

a. Pinch points of gears and the run-on point where a belt or chain contacts a sheave, sprocket or idler.
b. Outside faces of pulley, sheaves, sprockets and gears on rotating drives.
c. Rotating parts with projections such as exposed bolts, keys or set screws.
d. Revolving shafts, except smooth (without keyways, splines, etc.) shaft ends protruding less than one-half the diameter of the rotating element.
e. Implement input drive line.
f. Functional components.

4.1.3 Shields shall remain functional under the forces that would be applied by a 120 kg (265 lb) individual leaning on, falling against or stepping on them. This applies only to those forces that could be expected in normal machine operation or maintenance.

4.1.4 Equipment with access doors and shields which can be opened or removed while components continue to rotate more than 7 seconds after the power is disengaged, shall have: (1) visible or audible indication of rotation and (2) a suitable safety sign per 4.2.3 near the opening.

4.1.5 Access doors, guards, and shields which must be opened for normal servicing, shall be easily opened and closed.

4.2 Labels, Safety Signs and Instructions

4.2.1 CONTROL IDENTIFICATION—The controls furnished with the machine and their direction of motion for stopping, starting, speed control, and operation, whose functions are not obvious shall be identified by a label per 4.2.3. Symbols as provided in SAE J1500 may be used for control identification.

4.2.2 MACHINE IDENTIFICATION—The machine shall be provided with identification per 4.2.3 giving model number, serial number, and the name and address of either the U.S. or Canadian source of replacement parts and service.

4.2.3 LABELS—Labels and name plates provided on units shall meet the following minimum requirements:

a. Labels shall form a durable bond with the base material surface and shall show no appreciable loss of adhesion during weathering exposure. Labels shall not curl at the edges. Labels shall not lose legibility or suffer appreciable loss of adhesion when exposed to occasional contact with gasoline or oil.
b. The label shall meet the durability requirements of SAE J115 for permanent signs and safety signs shall meet all requirements of SAE J115.
c. Embossed, indented, cast or molded labels, shall be considered sufficient to meet the requirements of this section.
d. Metal plates over 0.48 mm (0.019 in) thick with embossed or etched lettering and fastened with rivets or equivalent fastening means shall be considered sufficient to meet the requirements of this section.

4.2.4 SAFETY SIGNS—Safety signs per 4.2.3 shall be displayed on the machine advising of other recognized hazards not itemized elsewhere in this document. A safety sign shall be included advising not to mow in transport position.

4.2.5 OPERATION, SERVICE AND MAINTENANCE INSTRUCTIONS

4.2.5.1 *General Requirements*—Written instructions shall be provided with the equipment explaining proper operation of the machine plus proper operational and service procedures and necessary maintenance procedures to avoid potential hazards. (See also SAE J920)

The manual shall also advise that:

"In addition to the design and configuration of equipment, hazard control and accident prevention are dependent upon the awareness, concern and prudence and requires suitable training of personnel involved in the operation, transport, maintenance and storage of equipment."

4.2.5.1.1 Written hazard avoidance instructions shall include identification of the need for personal protective equipment such as, but not limited to, protection for the eyes, ears, feet, hands and head.

4.2.5.1.2 The operator's manual shall contain instructions so that a person unfamiliar with the mower will have required information to prepare the mower for operation and to adjust, start, operate, transport, stop, park and unhitch the mower.

4.2.5.2 *Stored Energy Devices*—Any stored energy device such as, but not limited to, spring loaded mechanisms, and pressurized fluid systems, such as hydraulic accumulators, which can be disconnected, disassembled or freed in such a way to release energy or material in a hazardous manner, shall have an appropriate safety sign on or near the device. The safety sign shall include instructions for de-energizing and proper disassembly or include a reference to instructions provided in the operator's manual.

4.2.5.3 *Hydraulic Hazards*—(If applicable) The operator's service and maintenance manuals shall contain:

a. Information that hydraulic fluid escaping under pressure can have sufficient force to penetrate skin and cause serious injury, and that if fluid is injected into the skin, it may result in gangrene if the fluid is not surgically removed within a few hours by a doctor familiar with this form of injury.
b. Information cautioning to keep body and hands away from pin holes or nozzles which eject hydraulic fluid under high pressure and to use paper or cardboard and NOT HANDS to search for leaks.
c. Information cautioning the operator to make sure all hydraulic fluid connections are tight and all hydraulic hoses and lines are in good condition before applying pressure to the system.
d. Information explaining how to minimize the hazard during the relieving of all pressure or force in each system before disconnecting the lines or performing work on the system.

4.3 Pressurized Components

4.3.1 Hydraulic hoses furnished with the mower shall meet the requirements of the applicable section of SAE J517 based on the working pressure of each system.

4.3.2 Pressurized hoses, lines and components furnished with the mower shall be located or shielded so that in the event of rupture, a stream of fluid is not discharged directly onto the operator from within the operator zone when the person is in that zone. (See SAE J898)

5. Machine Requirements

5.1 Tongue—Any trailed unit should avoid a hitch connection characteristic which could move uncontrollably upward when disconnected. If not available, then it must have a conspicuous safety sign per 4.2.3 in the vicinity of the hitch point identifying the hazard. Also see SAE J208.

5.2 Attachment Means—Three-point hitch mounted and semi-mounted mowers shall be attached to the propelling machine by means of one or a combination of the following SAE standardized attachments: SAE J715 and SAE J909.

5.3 Machine Controls—Means to shut off machine shall be provided within convenient reach of operator in normal operator position.

Multi-section machines shall have the means to disconnect power to any section which can be carried in a raised or transport position while operation continues with another section.

6. Functional Component Requirements

6.1 Discharge Opening Safety Sign—A safety sign per 4.2.3, easily legible from a standing position, shall be placed on the machine at or near each discharge opening. It shall use the signal word, DANGER, and advise of the blade contact and thrown object hazards and advise that the machine shall not be operated unless deflectors, attachments or guards are in place.

6.2 Guarding & Shielding—Functional components which must be exposed for proper function, shall be shielded to prevent direct discharge of material into the normal operator position, except arm-type mowers. Any movable or removable guard(s) shall conform to the following.

6.2.1 A safety sign per 4.2.3 shall be affixed to the machine in a prominent location stating that the machine shall not be operated without guard(s) in place.

6.2.2 The operator's manual shall state that the machine shall not be operated without guard(s) in place.

6.2.3 If a guard is constructed of woven fabric, or other such material which may be subject to rapid wear or deterioration, the machine shall bear a label per 4.2.3 stating that it may require frequent inspection and possible replacement with parts of equal or better quality.

6.3 Cutting Elements—The components which are used to attach the cutting elements shall not become worn or fail in a hazardous manner before the elements themselves are worn beyond practical use.

6.4 Requirements for Flail Mowers and Flail Power Rakes

6.4.1 REQUIREMENTS FOR OPENINGS—Openings in the housing for the entrance and discharge of material to be cut and for other purposes shall be limited in accordance with 6.4.1.1 and 6.4.1.2.

6.4.1.1 Units that eject the material forward in the direction of ground travel when cutting shall limit the path of the ejected material to the space below a horizontal plane intersecting the centerline of the tractor rear axle, rearward of the tractor rear axle. But in no case shall the angle of the trajectory exceed 10° maximum upward angle tangent to the tip of the blades relative to the supporting surface. (See Figure 1.)

6.4.1.2 Units that eject material rearward to the direction of travel shall limit the path of the ejected material to a downward direction relative to the supporting surface. Any ejected material shall be directed to contact the ground within 500 mm (20 in) from the mower housing.

7. Test For Machine Components

7.1 Test Conditions, General

7.1.1 ASSEMBLY—The machine shall be completely assembled and mounted on or attached to its propelling machine except for tests where mounting on a suitable test fixture is designated, or, where necessary, the machine unit may be tested while separated from the power unit and power provided by some other means. However, speeds and positions must be the same as when on or attached to the propelling machine. Adjustable guards shall be set in the most open position for the test.

7.1.2 MACHINE POSITION—The machine shall rest on a horizontal surface and in a horizontal position that is flat within two (2) degrees.

7.2 Foot Probe Test—(Not required on arm-type mowers)

7.2.1 TEST EQUIPMENT—Foot Probe (See Figure 2.)

7.2.2 TEST PROCEDURE—The foot probe shall be held in a vertical plane and rocked vertically a maximum of 15° up and down from level while simultaneously being raised and lowered and also swung sideways as far as possible as shown in Figure 2. The probe must be inserted as far as possible at any point around the blade enclosure with a force of 110N (25 lb) with the machine set in the highest and also the lowest cutting positions, (except the highest cutting position for this test shall not exceed 200 mm (7.8 in)). If the blade path height is different for different blade speeds or blade options, the test shall include the two blade height or cutting diameter extremes. Components of the mower or machine, or both, such as frames, etc. may be considered as part of the blade enclosure for the purpose of this test.

7.2.3 TEST ACCEPTANCE—The probe shall not enter the running path of the blade or blade assemblies as verified by slow manual rotation and swinging of the blades with all power off.

7.3 Impact Tests

7.3.1 TEST EQUIPMENT—A test obstruction as shown in Figure 3, shall be used.

7.3.2 TEST CONDITIONS—The cutting height shall be set to 50 mm (2 in). The unit shall be operated at 10% over the manufacturer's maximum specified speed.

7.3.3 SUDDEN IMPACT TEST PROCEDURE—The unit shall be dropped three times onto the test obstruction of Figure 3 so that the entire cutting width of the cutting unit interferes 13 to 25 mm (0.50 to 1 in) with the test obstruction for 30 seconds.

7.3.4 REPEATED IMPACT TEST PROCEDURE—The unit shall be moved forward from a point rearward of the test obstructions at the rate of 1.6 km/h (1 mph), passing over the test obstruction 25 times.

7.3.5 TEST ACCEPTANCE—None of the parts should fracture, break, loosen, or deform in a manner hazardous to the operator or bystander except that failure of blades during the second or third drop, or pass shall not constitute failure of this test.

7.4 Blade Unbalance Tests

7.4.1 TEST EQUIPMENT—A timer shall be used.

7.4.2 TEST CONDITIONS—One horizontal row of cutting elements including attaching hardware shall be removed, except if blades are not in even rows, then 20% of the cutting or raking elements, including attaching hardware, shall be removed in such a manner as to create the most severe unbalance condition.

7.4.3 TEST PROCEDURE—The unit shall be operated at the manufacturer's maximum specified speed for 2 min.

7.4.4 TEST ACCEPTANCE—See 7.3.5.

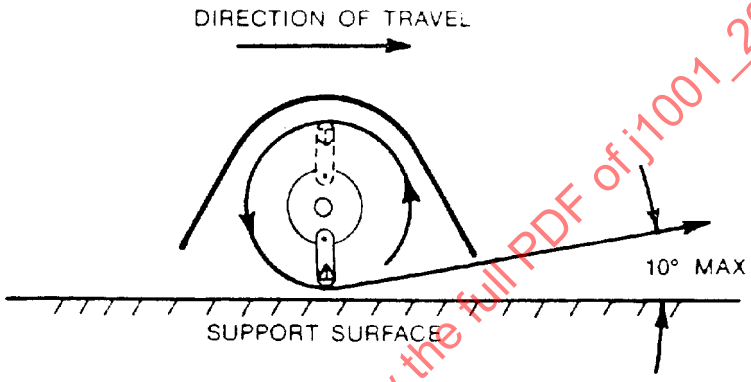

FIGURE 1—FLAIL FORWARD TRAJECTORY