

Submitted for recognition as an American National Standard

## THREE POINT HITCH (TYPE A) BACKHOE PERSONNEL PROTECTION

**Foreword**—This Document has not been changed other than to put it into the new SAE Technical Standards Board Format.

1. **Scope**—Minimum performance criteria for operator and bystander protection in this document apply to three point hitch (Type A) backhoes as defined in SAE J326 when mounted on any agricultural tractor (SAE J1150) or other off-road self-propelled work machine (SAE J1116 JUNE 81). This criteria includes backhoes which may not be manufactured and/or marketed by the same company that manufactures and/or markets the propelling machine and is intended for the backhoe manufacturer.

1.1 **Purpose**—To establish minimum performance criteria for operator and bystander protection from machinery hazards for three point hitch (Type A) general purpose backhoes which are 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 latest revision of SAE publications shall apply.

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

SAE J49—Specifications Definitions-Hydraulic Components

SAE J115—Safety Signs

SAE J154—Operator Enclosures Human Factor Design Considerations

SAE J185—Access Systems for Off-Road Machines

SAE J326—Nomenclature-Hydraulic Backhoes

SAE J517—Hydraulic Hose

SAE J715—Three-Point Free-Link Hitch Attachment of Implements to Agricultural Wheeled Tractors

SAE J725—Mounting Brackets and Socket for Warning Lamp and Slow-Moving Vehicles (SMV) Identification Emblem

SAE J833—USA Human Physical Dimensions

SAE J899—Operator's Seat Dimensions for Off-Road Self-Propelled Work Machines

SAE J909—Three-Point Hitch, Implement Quick-Attaching Coupler, Agricultural Tractors

SAE J920—Technical Publications for Off-Road Work Machines

SAE J1116—Categories of Off-Road Self-Propelled Work Machines

SAE J1150—Terminology for Agricultural Equipment

SAE J1170—Rear Power Take-Off for Agricultural Tractors

SAE J1501—DRAFT

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**2.2 Related Publications**—The following publications are provided for information purposes only and are not a required part of this document.

2.2.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J232—Industrial Rotary Mowers

2.2.2 ANSI PUBLICATION—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ANSI B71.4-1984—American National Standard for Commercial Turf Care Equipment-Safety Specifications.

### 3. Definitions

**3.1 Backhoe Components**—See SAE J326.

**3.2 Functional Component**—A working mechanism of an attachment or implement designed to perform a specific task such as the bucket of a backhoe.

**3.3 Inadvertent Contact**—Contact between a person and machinery hazard, or other type of hazard, resulting from the person's unplanned action during normal operation or servicing.

**3.4 Label**—A durable label used as a safety sign or for instruction or identification and that shall meet or exceed the requirements of Section 4.3 of this document.

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

**3.6 Normal Operator Position**—The space within operator zone (SAE J154a) occupied by the operator while operating a backhoe. The operator is sitting on the backhoe seat with hands on the backhoe control levers and feet on areas provided for foot placement.

**3.7 Power Take Off (PTO)**—An external shaft on the rear of a propelling machine to provide rotational power to implements. (SAE J1170 JUN80)

**3.8 Propelling Machine**—A tractor or self-propelled work machine.

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

### 4. General Requirements

#### 4.1 Guarding And Shielding

4.1.1 Guarding and shielding shall be provided to protect against inadvertent contact with machinery hazards during normal mounting, starting, operating, or dismounting of the equipment.

4.1.2 The following are some potential hazard areas:

1. Possible pinch points between moving components and the operator.
2. Implement or pump input drive line assembly.

## SAE J1518 Issued JUN86

- 4.1.3 Shields shall remain functional under the forces that could be applied by a 120 kg (260 lb) individual leaning on, falling against or stepping on them. This applies only to those forces that could be expected in normal machine operation and maintenance.
- 4.1.4 Equipment with access doors and shields which can be opened or removed while components continue to rotate more than 7 s after the power is disengaged, shall have:
- Visible or audible indication of rotation and
  - A suitable safety sign per SAE J115
- 4.1.5 Access doors, guards and shields which must be opened for normal servicing, shall be easily opened and closed but shall not be readily detached from the machine.
- 4.1.6 Safety signs per 4.3.2 shall be affixed to the backhoe in a prominent location stating that the backhoe shall not be operated without removable shield(s) in place.

### 4.2 Controls

- 4.2.1 CONTROL FUNCTIONAL REQUIREMENTS—On machines designed after the publication of this document, the boom control shall have four positions as follows:
- |            |   |
|------------|---|
| Position A | Moving towards the operator from neutral shall raise the boom.  |
| Position B | Neutral shall hold the boom's vertical position blocking both ports of the boom cylinder valve.   |
| Position C | Moving the control away from the operator shall cause the boom to lower.  |
| Position D | Moving the control further away from the operator beyond Position "C" shall enter a "float" position, or some other means shall be provided so that pressure is relieved from the end of the boom cylinder which forces the boom down. The valve control shall return automatically from Position "D" to neutral when released. |
- 4.2.2 CONTROL IDENTIFICATION—The controls furnished with the backhoe, and their direction of motion for stopping, starting, speed control and all operating functions shall be identified by a label per 4.3.3.
- 4.2.3 CONTROL STANDARDIZATION—The backhoe operator controls shall conform to SAE J1501 DRAFT except that the boom control shall also include the float position as specified in paragraph 4.2.1-D.

### 4.3 Labels & Safety Signs

- 4.3.1 MACHINE IDENTIFICATION—The backhoe shall be provided with identification per paragraphs 4.3.4 or 4.3.5 giving model number, serial number and the name and address of either the U.S. or Canadian source of replacement parts and services.
- 4.3.2 SAFETY SIGNS—Safety signs shall conform to all requirements of SAE J115.
- 4.3.3 LABELS—Labels shall meet the durability requirements of SAE J115.
- 4.3.4 CAST LABELS—Embossed, indented, cast or molded metal labels shall be considered sufficient to meet the requirements of this section.
- 4.3.5 METAL PLATES—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.

#### 4.4 Operation, Service and Maintenance Instructions

4.4.1 GENERAL REQUIREMENTS—Specific written instructions shall be provided with the equipment explaining proper operation of the machine plus proper operational, service and maintenance procedures to avoid potential hazards. (See also SAE J920)

The operators 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, prudence, and proper training of personnel involved in the operation, transport, maintenance, and storage of equipment."

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

4.4.1.2 The operator's manual shall contain instructions so that a person will have adequate information to prepare the backhoe for operation, adjust, start, operate, transport, stop, park and unhitch the backhoe.

4.4.1.3 The operator's manual shall include backhoe specifications per SAE J49.

4.4.2 HYDRAULIC WARNINGS—The operator's, service and maintenance manuals shall contain:

1. A warning that hydraulic fluid escaping under pressure can have sufficient force to penetrate skin and do serious damage, 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.
2. A warning to keep body and hands away from pin holes or nozzles which eject hydraulic fluid under high pressure and to use paper or cardboard, not hands, to search for leaks.
3. A warning to make sure all hydraulic fluid connections are tight and all hydraulic hoses and lines are in good condition before operating.
4. Instructions on how to relieve all pressure in the hydraulic system before disconnecting lines or servicing system.

#### 5. Machine Requirements

##### 5.1 Operator Zone - Pressurized Components

5.1.1 Pressure hydraulic hoses furnished with the backhoe, subjected to pressures above 1725 kPa (250 psi) shall meet the requirements of SAE J517.

5.1.2 Pressurized hoses, lines and other hydraulic components furnished with the backhoe 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 in the normal operator position per paragraph 3.6.

5.1.3 Hand holds and steps shall be provided for mounting and dismounting per SAE J185 JUN81.

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 as to release energy or material in a hazardous manner, shall have an appropriate safety sign on or near the device. The sign shall include instructions for de-energizing and proper disassembly or include a reference to instructions provided in the operator's manual.

**5.3 Attachment Means**—Three point hitch backhoes shall be attached to the propelling machine by only the following SAE standardized attachment means: SAE J715 SEP83 and use only the two lower attaching points, but must not be capable of accepting the SAE standard top link.

If a three point hitch top link is required for the mounting, it shall be furnished with the backhoe as standard equipment and must be used in the structural integrity test (Section 6). The top link point on the backhoe shall be so designed that a SAE standard three point top link cannot be used.

- 5.3.1 A means (limiter device) shall be provided with the backhoe to prevent upward movement of the backhoe relative to the tractor which could be hazardous to the operator, and shall meet the requirements of the tests in Section 6.
- 5.3.2 CRUSHING HAZARD—A DANGER safety sign per 4.3.2 including a pictorial depicting the hazard of an operator being thrust upward into any overhead structure such as a ROPS or cab shall be provided in a prominent location advising of the proper use and adjustment of the limiter device and proper hook-up procedures. It shall also advise that use of backhoes is prohibited on machines where the minimum space envelope around the operator zone is inadequate as defined by SAE J154a. However, since this document is for mobile machine operation and the backhoe use is stationary, the 1050 mm (41 in) minimum head clearance is reduced to 915 mm (36 in) minimum from the seat index point (The seat index point is 100 mm (4 in) above the seat surface which gives a total of 1000 mm (40 in) head room.) (SAE J899). This allows for the 965 mm (38 in) 95th percentile man per SAE J833.
- 5.3.3 Information shall be provided on a label on the backhoe and in the operator's manual specifying the recommended hitch category and minimum tractor lift force capacity necessary to lift and support the backhoe in operation and transport.
- 5.3.4 A safety sign per paragraph 4.3.2 shall be provided on the backhoe and a warning in the operator's manual to warn against its use on a three-point "Quick Attaching Coupler". (SAE J909 APR80)
- 5.3.5 A safety sign shall be provided on the backhoe and instructions in the operator's manual advising that front end weight shall be added as needed to provide a minimum of 20% of the total gross weight on the front wheels of the propelling machine with the backhoe in transport position. The operator's manual shall instruct the operator to drive carefully, especially on turns and slopes while transporting.
- 5.3.6 Instructions shall be provided in the manual that prohibit installing the backhoe with required counterweights on a propelling machine which would exceed the ROPS certification label maximum machine mass.

#### **5.4 Transport Requirements**

- 5.4.1 A means shall be provided to prevent the boom from swinging freely or the bucket from contacting the ground during transport, in the event of any hydraulic component failure. The locking means shall be adequate to resist maximum available hydraulic force without failure.
- 5.4.2 An SMV identification emblem attaching means per SAE J725 shall be provided on the rear of the backhoe.

#### **5.5 Hydraulic Compatibility**

- 5.5.1 If the backhoe hydraulic system is operated by the propelling machine power take-off, instructions shall be provided in the operator's manual and on a label per paragraph 4.3.3 advising of the maximum allowable PTO speed for this system.

5.5.2 If the backhoe utilizes the propelling machine hydraulic system, a label shall be provided on the backhoe and information in the operator's manual advising of the maximum permissible flow rates and pressure that may be used. Also, the type of hydraulic system that can be accepted or specific system requirement shall be specified.

**5.6 Operating Warnings**—Information shall be provided on a safety sign(s) per paragraph 4.3.2 on the backhoe and in the operator's manual advising of operating limitations and hazards such as, but not limited to, the following:

1. Check the operating area to be dug for any possible overhead or underground lines such as electric, gas, oil, water, etc., and extreme caution must be exercised in these areas where present. Consult local utilities before digging.
2. Operate backhoe controls ONLY from the normal backhoe operator position.
3. Operate only with stabilizer(s) down and on firm footing. Stay clear of steep areas or excavation banks that are soft or could give way.
4. Keep bystanders away from the maximum swing reach area and the stabilizers.

## **6. Structural Integrity Test of Backhoe Mounting**

### **6.1 Test Conditions**

6.1.1 **BACKHOE POSITION**—The backhoe shall be in a centered mounting position on a horizontal surface that is level within 5 deg. It may deflect out of these limits during the test.

6.1.2 **ASSEMBLY**—The backhoe shall be fully assembled, without a bucket, mounted on a test fixture or propelling machine adequate to provide support during the test. No operator should be on the unit during the test. The test fixture or propelling machine shall be tied down as needed for the test to prevent lift-off of any support point.

### **6.2 Test Procedure**

6.2.1 The backhoe shall be positioned and tested as indicated in each of the positions listed in Table 1.

6.2.2 Force for the test shall be applied vertically at the bucket hinge point, either upward or downward as indicated, and may be achieved either through adding additional hydraulic pressure into the system with the backhoe secured or by adding mechanical force with the hydraulics in the locked position. Any circuit relief valves that would relieve before achieving the desired force shall be blocked.

6.2.3 Force is to be determined by measuring the hydraulic pressure in the appropriate circuit.

6.2.4 The test force called for in Table 1 is the result of the factor that is to be multiplied by the maximum pressure that can be applied by the backhoe system when reaching either the circuit relief pressure or the system relief pressure for those circuits that would limit vertical force to the bucket pivot point, whichever is lower.

6.2.5 Where stabilizers are specified to be in the down position, they shall be positioned to support the backhoe in a normal working position or up against the lift limiter, whichever is higher. When specified in the "up" position, they shall remain free of contact with the test surface during the test.

6.2.6 Where the boom position calls for being extended, the dipperstick cylinder shall be at the end of its travel extending the dipperstick in the most extended position, and the boom cylinder shall be adjusted to position the bucket hinge point 300 mm (12 in) to 1200 mm (47 in) above grade.

TABLE 1—TEST MODES

Test No.	Boom/Dipperstick Position	Direction of Force(a)	Stabilizer Position	Test Force Applied
				Factor (6.2.4)
1	extend straight rearward	down	down	3X
2	extend straight rearward	down	up	2X
3	extend straight rearward	up	either	2X
4	extended 90 deg to the right	down	down	2X
5	extended 90 deg to the right	down	up	1X
6	extended 90 deg to the left	down	down	2X
7	extended 90 deg to the left	down	up	1X
8	retracted straight rearward	up	either	2X

- 6.3 Test Acceptance**—The backhoe mounting shall pass the test if there is no failure or visible permanent bending or permanent change of shape of any of the backhoe subframe, mounting linkage or lockdown structure or devices or parts related thereto.

PREPARED BY THE SAE OFF-ROAD MACHINERY TECHNICAL COMMITTEE SC25—  
GENERAL PURPOSE TRACTORS (INDUSTRIAL)

## SAE J1518 Issued JUN86

**Rationale**—The changes are as follows;

This recommended practice is a new development for design and performance requirements on three point hitch (Type A) backhoes as defined in SAE J326.

1. Scope: Three point hitch (Type A) backhoes may be used on tractors not manufactured by the same company manufacturing the backhoe. Certain combinations of tractors and three-point mounted backhoes may create a crushing hazard condition if the operator is thrust up into a ROPS or cab. Concern for this condition and identification and protection against other possible hazards is the reason for the development of this document and for this reason, the tests should be conducted by the backhoe manufacturer.

2. Definitions: These are taken from other referenced standards.

3. General Requirements: These are taken from other documents such as SAE J232 DEC84 and ANSI B71.4 - 1984.

3.1 Three point hitches may be lifted inadvertently during backhoe operation by the lifting force created when pushing downward with the bucket. This could create a crushing hazard to the operator. If the operator is thrust forward and into the control lever in this situation, he will then be forced to push the boom control lever away from him and into position "D". In position "D", the pressure will be released from the end of the boom cylinder which forces the boom down, in which case the backhoe will drop free and eliminate the hazard.

Note that to reach this "float" position "D", the lever must first be pushed through the "power down" position "C" which is attempting to force the boom down as fast as the flow will make it go. Moving from there on into position "D" will not cause an increase in the drop speed since, in this position, no pressure is being applied to force the boom down.

The spring return is required so if a control is bumped accidentally, the boom won't continue to fall when released.

4. Machine Requirements:

4.1 This is not meant to require shielding of all hoses and components on the boom, dipperstick, etc. but only those in close proximity to the operator.

4.2 The top link may be subjected to loads in excess of those normally applied to a three point hitch top link. The three point hitch (Type A) backhoe test will allow the backhoe manufacturer to assure the structural integrity of both the mounting and the top link. The requirement that an SAE standard toplink not interchange is to prevent the use of a substitute top link which may not have adequate strength.

4.2.1 The crushing hazard condition explained in paragraph 3.1 will also be avoided by proper use of the limiter device.

4.2.2 The safety sign shall be provided to warn the operator of the crushing hazard which may not be apparent and alert him to the need for using the limiting devices provided. Certain tractor/backhoe combinations do not provide adequate clearance for the operator and therefore the use of the backhoe on these tractors is prohibited. The 915 mm (36 in) clearance from the seat index point (which is 100 mm (4 in) above the seat surface) gives a total of 40 in of head room. This allows 50 mm (2 in) head clearance for the 95th percentile man sitting erect as defined in SAE J833.