

(Provisional Translation)

Autonomous Agri-machinery Test (tractors)

Main Test Methods and Criteria

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(Note) The purpose of this provisional translation is only for reference.
For authenticity, please refer to NARO's Japanese texts available at:
https://www.naro.go.jp/iam/contents/test/pdf/kensa_002_010_4en.pdf

Table of contents

1. Scope	• • • • •	1
2. Terms and definitions	• • • • •	1
3. Test methods	• • • • •	2
3-1 Test items	• • • • •	2
3-2 Test conditions	• • • • •	2
3-3 Inspections and test methods	• • • • •	2
3-3-1 Structural inspection	• • • • •	2
3-3-2 Manual mode function test	• • • • •	3
3-3-3 Operation state indication function test	• • • • •	3
3-3-4 Person/obstacle detection function test	• • • • •	4
3-3-5 Other necessary safety function test	• • • • •	6
3-3-6 Operability test	• • • • •	6
4. Criteria of the test	• • • • •	7
Supplementary Provisions (Optional test)	• • • • •	8

1. Scope

The methods and criteria of this test are applied to an agricultural tractor (riding type) (hereinafter referred to as tractors) that autonomously operates in an agricultural field without an onboard operator but is subject to the supervision of the operator located in or near the field.

2. Terms and definitions

The terms used in the methods and criteria for this test are as follows:

(1) Autonomous operation

Autonomous operation means the tractor autonomously performs farm work operation using signals such as GNSS and camera images.

(2) Autonomous mode

Autonomous mode means a state of the tractor in which autonomous operation is enabled.

(3) Manual mode

Manual mode means a state of the tractor in which autonomous operation is disabled.

(4) Operation state

Operation state means the tractor is in the following state; autonomous operation state, autonomous operation enabled state, and autonomous operation disabled state.

(5) Autonomous operation state

Autonomous operation state means the tractor is in autonomous operation.

(6) Autonomous operation enabled state

Autonomous operation enabled state means the tractor can start autonomous operation despite the operator instructs it to start.

(7) Autonomous operation disabled state

Autonomous operation disabled state means the tractor cannot start autonomous operation when the operator instructs it to start.

(8) Hazard zone

Hazard zone is an area where the movement of the tractor and/or its implement may lead to severe damage to a person/obstacle around the tractor and its implement.

(9) Warning zone

Warning zone is an area around the tractor and/or its implement where people/obstacle may enter the hazard zone.

(10) Operation zone

Operation zone means an area inside the agricultural field where the operator instructs the tractor, including its implement, to operate autonomously.

3. Test methods

3-1 Test items

The test will be conducted on the following inspection and test items.

(1) Structural inspection

(2) Manual mode function test

(3) Operation state indication function test

(4) Person/obstacle detection function test

(5) Other necessary safety function test

(6) Operability test

3-2 Test conditions

(1) Measuring instrument

Measuring instruments shall be verified and corrected.

(2) Discontinuation of Test

The inspection and test shall be discontinued for the following occasions:

a) When the tractor to be inspected is different from its normal state (the state in which the tractor and its implement have been manufactured as designed and the quality is guaranteed), or when a proper inspection or test cannot be performed due to the occurrence of damage, abnormality, etc.

Notwithstanding the above, inspection and test can be continued when the inspecting agency recognizes that the reason for the damage/abnormality cannot be attributed to the applicant, or the damage/abnormality is minor, and by replacing parts, a proper inspection or test can be promptly continued.

b) An occasion the applicant requests to discontinue the inspection and/or test.

3-3 Inspections and test methods

3-3-1 Structural inspection

(1) Purpose

This inspection checks the equipment required for autonomous operation.

(2) Inspection and test items

a) Autonomous mode/ manual mode switching device

- b) Indicator displaying the operation state (hereinafter referred to as the indicator)
- c) System required for autonomous operation
- d) Function to prevent exceeding the operation zone
- e) Other necessary equipment, etc.

3-3-2 Manual mode function test

(1) Purpose

This test checks the tractor's behaviors in the autonomous operation disabled state.

(2) Test conditions

- a) The tractor shall be placed on a flat and paved surface.
- b) The test shall be conducted with the tractor parked.

(3) Test method

- a) Check the behaviors of the tractor in manual mode when the operator instructs it to start autonomous operation.

3-3-3 Operation state indicator function test

(1) Purpose

This test checks that the operator can recognize the tractor's operation state using indicators.

(2) Test conditions

- a) The tractor shall be placed on a flat and paved surface.
- b) The test shall be performed on a parked or operating tractor in autonomous mode.

(3) Test method

- a) Check the indication when the tractor is in autonomous operation state.
- b) Check the indication when the tractor is in autonomous operation enabled state.
- c) Check the indication when the tractor is in autonomous operation disabled state.

3-3-4 Person/obstacle detection function test

(1) Purpose

This test checks that the tractor detects a person or an obstacle approaching without contact in autonomous operation. And warns people in the surroundings and stops autonomously.

(2) Test conditions

- a) The tractor shall be placed on a flat and paved surface.
- b) The test shall be performed with the tractor moving (permissible maximum speed) in autonomous mode.
- c) The test obstacle shall conform with ISO18497: 2018 (Fig. 1).
- d) The test obstacle shall be placed, both in front or behind the tractor, on the center line of the roll axis direction of the tractor (hereinafter referred to as the center line) as well as the straight lines parallel to the center line passing through the outermost side of the tractor including the implement that the applicant mounts (Fig. 2).

(3) Test method

1) Test in the warning zone

- a) With the test obstacle placed in front of the tractor, as the tractor moves forward, check the behaviors of the tractor when the test obstacle enters the warning zone.
- b) With the test obstacle placed behind the tractor as the tractor moves backward, check the behaviors of the tractor when the test obstacle enters the warning zone.

2) Test in the hazard zone

- a) With the test obstacle placed in front of the tractor, as the tractor moves forward, check the behaviors of the tractor when the test obstacle enters the hazard zone.
- b) With the test obstacle placed behind the tractor and the tractor moving backward, check the behaviors of the tractor when the test obstacle enters the hazard zone.

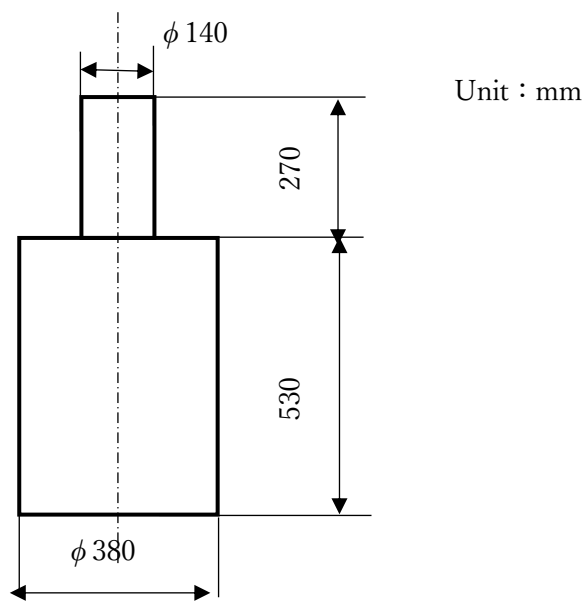


Figure1 : Test obstacle (conform with ISO18497 : 2018)

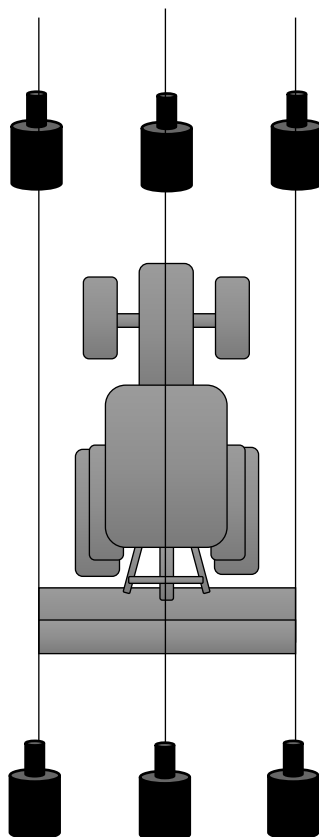


Figure2 Relative positions of the tractor and test obstacle

3-3-5 Other necessary safety function test

(1) Purpose

This test checks the operability of the pendant control device, etc., and safety functions in case of a communication failure.

(2) Test conditions

- a) The tractor shall be placed on a flat and paved surface.
- b) The test shall be performed on the tractor in autonomous mode, parked, and in operation.

(3) Test method

- a) Check the procedure to start autonomous operation.
- b) Check the tractor's behaviors when the operator instructs the tractor in autonomous operation to stop.
- c) Check the tractor's behaviors when a communication failure occurs between the pendant control device and tractor during autonomous operation.
- d) Check other functions that are considered necessary for safety.

3-3-6 Operability test

(1) Purpose

This test checks the operability and safety of the tractor throughout the procedures of autonomous operations, including establishing the operation zone.

(2) Test conditions

- a) The test shall be conducted in a field of 10 acres or more.
- b) The test shall be performed on the tractor in autonomous mode, moving at the machine's permissible maximum speed.
- c) The applicant shall select an implement that can be mounted to the tractor and mount it to the testing tractor.

(3) Test method

- a) In principle, a rectangular operation zone of 10 acres (50m x 20m) or more shall be established in the field.

- b) The inspecting agency shall set the tractor in the autonomous operation mode for the test, instruct the tractor to complete all the autonomous operations and works using the implement in the established operation zone, and check the behaviors of the tractor and the implement.

4. Criteria of the test

The criteria of this autonomous agri-machine test for tractors are as follows:

- (1) In the inspection of 3-3-1, equipment necessary for the autonomous operation is installed, and the equipment that requires the operator's inputs for operation is positioned so that it can be safely and easily handled by the operator in the normal working position. In addition, the functions and operation methods of the equipment are indicated. Furthermore, the tractor shall have a function to remain inside the operation zone during autonomous operation including the implement attached to it.
- (2) In the 3-3-2 test, the autonomous operation cannot be started in manual mode.
- (3) In the 3-3-3 test, the state of the tractor is indicated correctly, and the operator can easily recognize the state of the tractor.
- (4) In the test of 3-3-4 (3) -1), a warning signal shall be issued.
- (5) In the test of 3-3-4 (3) -2), the tractor and its implement must not come into contact with the test obstacle. Also, the tractor and its implement shall stop.
- (6) In the 3-3-5 test, the pendant control device has a safeguard to prevent incorrect operation.
- (7) In the 3-3-5 test, the tractor and its implement shall stop when the operator instructs the machine to stop using the pendant control device.
- (8) In the 3-3-5 test, the tractor shall stop autonomously when a malfunction happens, such as a communication failure between the tractor and the pendant control device.
- (9) In the 3-3-5 test, there must be no defects in the functions required for safety. In addition, when there is a failure in the system required for autonomous operation, the tractor shall not start autonomous operation.
- (10) In the 3-3-6 test, the tractor and its implement shall remain inside the established operation zone. In addition, there shall be no significant defects in operability and safety.

Supplementary Provisions (Optional test)

1. 1. Person/obstacle detection function test (on starting)

(1) Purpose

This test checks on starting autonomous operation, the tractor can detect person/obstacles without contact and not start moving.

(2) Test conditions

- a) The test shall be conducted on a flat and paved surface.
- b) The test obstacle shall conform with ISO18497: 2018 (Fig. 1).

(3) Test method

The test obstacle shall be placed in the hazard zone of the parked tractor in the autonomous operation enabled state (Fig. 3). Check the behavior of the tractor when the operator instructs the tractor to start autonomous operation.

2. Criteria of the test

In the test of 1 (3), the tractor and its implement shall not move when a test obstacle is in the hazard zone.

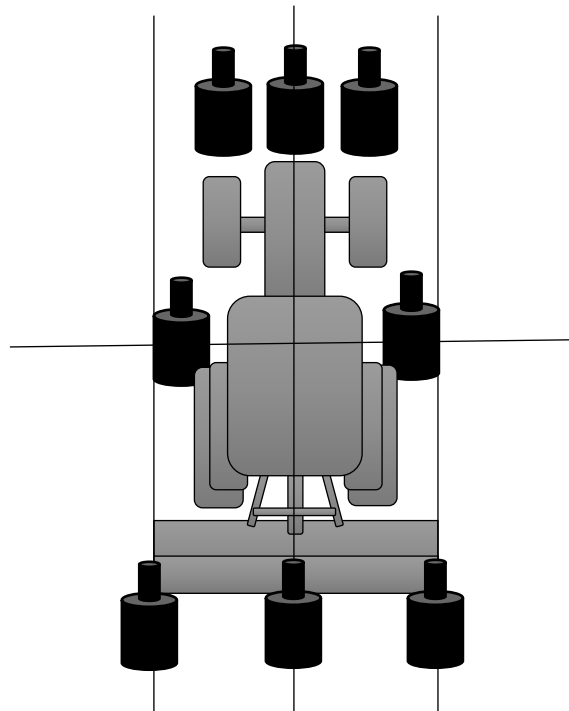


Figure 3 Example of placements of test obstacle