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Design Requirements For A Manual Stacked Sod Harvester

Prepared for Turf Australia

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EN-52—167-REP-001.3	25/07/2018	Minor changes post Open Day and SafworkNSW comments.

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1 Introduction

001 This report provides guidance to assess design modification to enhance safety of manually stacked turf harvesters.

002 A number of risks were identified during a coronial enquiry into a fatality involving a manually stacked turf harvester[1]. The findings and recommendations from the coroner to address these risks were taken up by Safework NSW and Turf Australia leading to the publication of a Safework NSW document[2].

003 While the Safework NSW document provides generalised guidance, the document lacked specific design detailing or methods of assessment. In order to provide design guidance, the Turf Association of Australia engaged EngAnalysis to distil the guidance from Safework NSW and relevant Australian Standards into a single practical guide.

004 This document provides growers and organisations involved in machine maintenance and modification with practical advice on possible modification to manually stacked turf harvesters for improved safety. The guidance is sufficiently broad to apply to a number of different configurations and machine types.

005 The guidance in this document does not address all risks for all operations and includes recommendations for training, risk assessment and ongoing machine inspection.

Figure 1 Manual Stacked Sod Harvester

1.1 Terminology:

006 The following terminology is used through this document

Shall: Required action or feature

Should: Recommended action or feature

Operator: Either a stacker or driver, may be one person performing both duties

Driver: Person driving the tractor and responsible for operating the harvester

Stacker: Person responsible for collecting the cut turf either rolled or slabbed and “stacking” the turf on a pallet

[1] Dec 2014 the NSW Coroners Court undertook hearings and realised its finding in the ROZS Blaine Case (file no. 2014/353755)

[2] The Safework NSW document is available on line: http://www.safework.nsw.gov.au/media/publications/health-and-safety/supply-and-use-of-turf-sod-harvesters

2 Background

007 Following a fatal incident in Dec 2014 the NSW Coroners Court undertook hearings and realised its finding in the ROZS Blaine Case (file no. 2014/353755). These findings and recommendation have been taken up by Safework NSW and Turf Australia. Safework NSW and the operators of Greener lawns turf farm have collaborated on an interpretation of the coroner's findings, with Safe work NSW producing a position and Greener lawns modifying a harvester.

2.1 Coroner's Recommendations

008 Recommendations from the Coroner's report include (relevant to this study):

1) *Prior to sale, suppliers of sod (turf) harvesters should consider the provision of mirrors/devices that allow the operator a larger field of vision to the rear of the plant and a reversing obstruction alarm to be installed.*
2) *Currently owned/operated sod (turf) harvesters, PCBUs should consider retro fitting mirrors/devices that allow the operator a larger field of vision to the rear of the plant and a reversing obstruction alarm where there is a risk of a person being struck.*
3) *Turf harvesting businesses are to implement a system of work where:*
    a) *the operator is to remain in control of the harvester at all times whilst the plant is in operation/use.*
    b) *whilst in operation the harvester is only to be driven in reverse when necessary*
    c) *stackers leave the harvester and move into a safe position where they can be seen by the operator*
    d) *the operator does not reverse until identifying that the stackers are in the safe location*
    e) *whilst reversing the operator monitors the path of travel and that stackers remain in sight out of the travel path, and*
    f) *the operator stops when the obstruction alarm sounds until they check the path is clear,*
    g) *workers are trained in the system of work*
4) *Turf harvesting businesses are to regularly monitor the work through supervision and consultation to ensure the system is being used and is effective.*

2.2 SafeWork NSW Position Paper

009 This position paper sets out engineering and operational controls that should be implemented by operators. The position paper states that from 1st October 2018 "supply and use of turf harvesters is restricted…."

010 …"hand stacking harvesters that are fitted with measures to control the risks of persons falling off, and being run over by reversing harvester."

011 Interestingly the controls are described as "should", leaving open the possibility that alternative or modified controls that achieve the desired outcome are possible. The following measures should be used for controlling the risk of persons falling off and/or being run over by a reversing harvester. The criteria from the SafeWork NSW position paper was that the design and installation of safety controls must be undertaken by a competent person.

Table 1 SafeWork NSW Engineering Controls

Hazard	Possible solutions for hand stacking harvesters
The stacker falling or exiting into the path of a reversing harvester	• Install guard rails on the platform at the back of the harvester • Where necessary, extend the rear platform backwards for the stacker's convenience and safety • Where necessary, extend the rear platform to the cutter side so as to be in line with the outer edge of the cutter • Install reversing cameras and rear-view mirrors.
Drivers getting on or off moving harvesters (a foreseeable misuse) and being run over	Install platforms between the front and rear wheels and wheel guards.
People getting crushed between harvesters and objects (e.g. workshop wall)	Install reversing alarms and reversing cameras.
People in the paddock being hit by the harvester	Consider installing obstruction alarms.

3 Operators Manual and Training

012 Owners require a copy of a relevant operator's manual from the manufacturer and must train operator accordingly. Where modifications have been made to the machine additional training material should be produced to reflect the changes.

013 Safe work methods relevant to individual machines and local practices should be developed and the operators trained accordingly.

014 Training records shall be maintained, and the training material updated at least annually.

4 OEM Machine Guards

015 All original machine guards or equivalent shall be installed on the machine, unless superseded by modifications that further reduce the risks that are isolated by the guard.

5 Machine Control

5.1 Emergency Stop

016 An Emergency stop (E-stop) device should be easily accessible in the stacker position. All E-stops should be in accordance with "Managing the risks of plant in the workplace: Code of practice - July 2014." This should be installed regardless of whether the harvester is used for single or multiple person operation.

5.2 Harvester Control

017 It is necessary for the operating team to maintain control of the machine at all times during machine operation[3].

018 It is understood that it is not uncommon for single person operation of these small harvesters, with one person performing driving and stacking, or for the driver to assist another person in stacking. It is understood that during some single person operation practices, the operator may dismount and mount the vehicle during a cutting operation.

Figure 2 Single Person Operation (ref: https://youtu.be/aOYtrtymbfk)

019 In order for this this to be conducted safely and for an "operator to remain in control at all times" a number of conditions should be met. These conditions are listed below:

5.2.1 Operational Controls

020 No person should mount or dismount the vehicle while it is in motion.

021 If the driver is to access and operate from the stacker platform, the driver shall set desired vehicle parameters, bring the vehicle to a complete and secure stop before dismounting to change positions to the stacker platform. Likewise, when dismounting the stacker position the vehicle shall be brought to complete and secure stop.

022 A practical realisation of a minimum set of controls is presented in Figure 3.

[3] The Coroner's recommendation "3a" is that "the operator remain in control at all times whilst in operation".

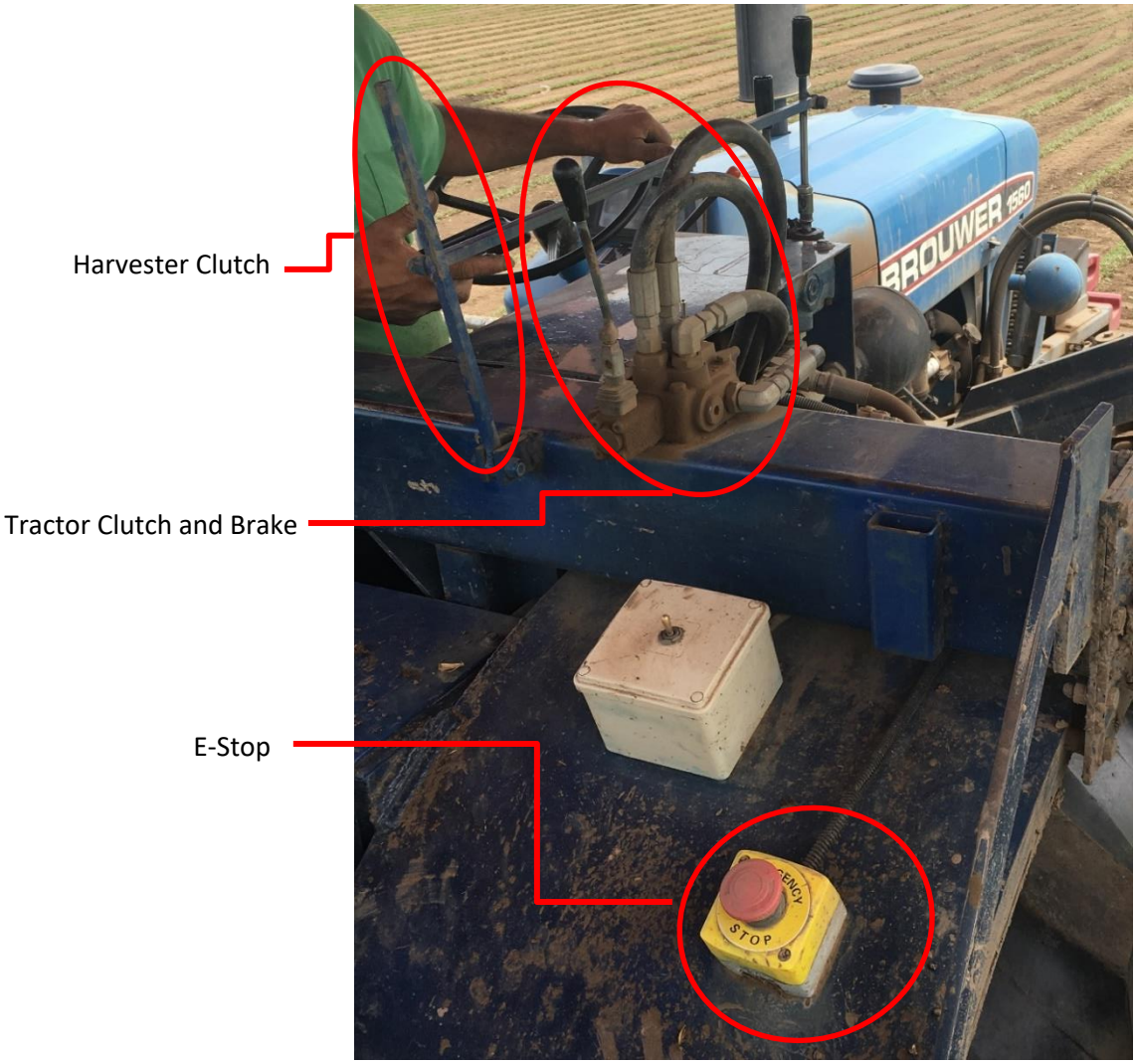


Figure 3 Stacker Controls

023 The following Tractor controls at the stacker position are required for remote operation:

1. The tractor shall have an autosteer capability; this is a common accessory for Sod harvesters
2. The stacker position at the rear of the tractor shall have a minimum of remote controls for the:
    a. Tractor brake and clutch - to stop and secure the vehicle
    b. Sod harvester clutch - to disengage the harvester operation
    c. E-Stop

5.3 Mirrors and Reversing Alarms

024 The tractor should consider the provision of mirrors/devices that allow the operator a larger field of vision to the rear of the plant and the installation of a reversing obstruction alarm.

6 Platforms & Safety Barriers

025 It is recommended that platforms and safety railings conform to AS1657-2013 *Fixed platforms, walkways, stairways and ladders - Design, construction and installation*. This section outlines specific design guidance for the design and construction of handrails and walkways.

6.1 Driver Access

026 It is recommended that regardless of operation mode (single person or multiple person operation) that the driver access has the following:

- Enclosed/guarded rear wheel such that the wheel is guarded to its outside extent
- A forward safety railing be installed, and designed in accordance with AS1657-2013
- If other railing is used, then it shall be designed in accordance with AS1657-2013

Figure 4 Modified Driver Access

6.2 Stacker Position

027 The stacker platform should be of a sufficient size to allow reasonable movement of the stacker's feet during operation. At a minimum this should be 600mm deep (550mm clear) and extend from the pallet with a gap no larger than 75mm to the outside edge of the harvester.

028 A safety barrier shall be in place to prevent forward falls between the stacker platform and harvester.

029 A safety barrier at the rear of the stacker platform shall be in place to prevent rearward falls.

030 Sufficient handholds shall be in place to allow the stacker to steady themselves.

031 The safety barriers and stacker platform shall extend the outer edge of the tractor wheels.

6.3 Design Guidance

6.3.1 Platforms

032 The following is based on AS1657-2013 and good design practice, it is intended to assist in the design of safe platforms and is not intended to replace AS1657-2013.

- Platform shall have a depth of no less than 600mm.
- Where guard rails are installed on both sides a clear depth shall be 550mm of any component (ref Figure 5 Walkway Width (ref. AS1657-2013)).

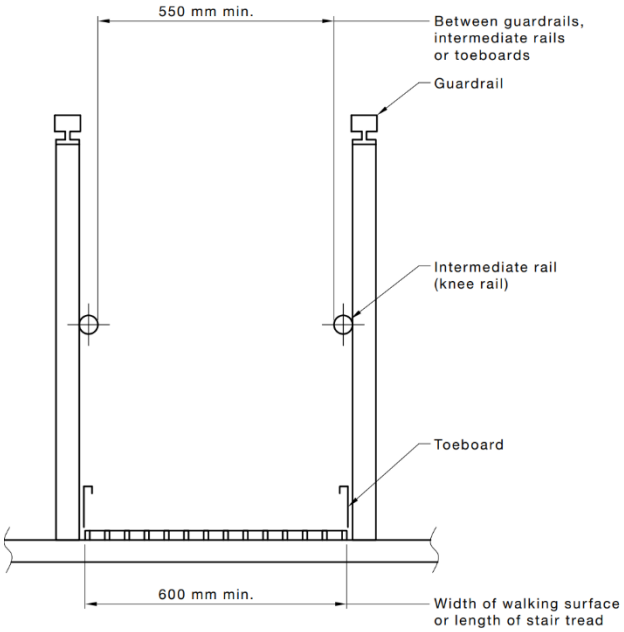


Figure 5 Walkway Width (ref. AS1657-2013)

- Platforms shall be level within 3^{o} (degrees) when vehicle is on level ground.
- Platforms shall be even within 5mm between section
- Flooring is recommended be made of manufactured of expanded metal, to allow drainage
- Structural element of the platform be of 50x50mm square tube
- Design Loads:
    a) Live load of 2.5kPa (255kg/m^2) evenly distributed on the platform
    b) 1.1kN (112kg) applied on a 100 x 100mm area at any point

6.3.2 Guard Rails

033 The following is based on AS1657-2013 and good design practice, it is intended to assist in the design of safe guard rails and is not intended to replace AS1657-2013. Guard rails shall conform to AS1657 and have the following attributes:

- Height 900-1100mm (may not apply to forward facing barrier)
- Shall have infill with a gap no larger than 450mm.
- Shall have 100mm toe board, with a gap no larger than 10mm to the floor.
- Where used as hand rails the dimensions shall be as per Figure 6.
- Guard rail design loads: no part shall elastically deform more than 100mm
    a) A force of 600N (61kg) at any point on the top rail, intermediate rail or post, outwards or downwards
    b) A distributed force of 350N/m (36kg/m) on the top or intermediate rail.
- Toe board design loads: 100N (10.2kg) outwards at any point, elastic deformation shall not exceed 10mm.

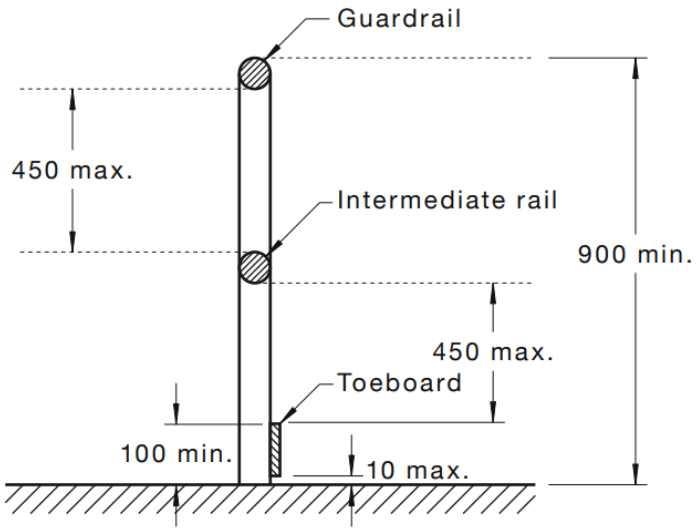


Figure 6 Typical Guard Railing (AS1657-2013)

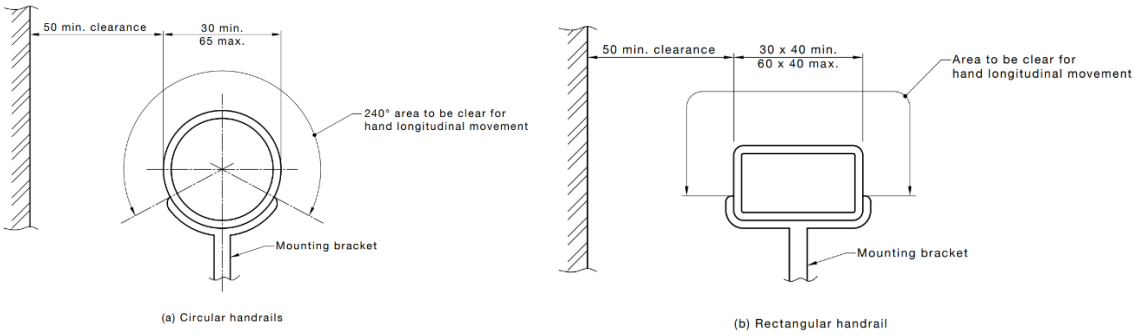


Figure 7 Hand Rail Dimensions (AS1657-2013)

6.3.3 Materials

034 AS1657-2013 makes some basic recommendations regarding material selection:

RECOMMENDED MINIMUM DIMENSIONS FOR TYPICAL STEEL COMPONENTS

Component	Steel dimensions and shape mm	Steel pipe (outside diameter) mm
Posts	65 × 65 × 5 angle	48.3 × 3.2 wt
Top rail	50 × 50 × 5 angle	33.7 × 3.2 wt
Intermediate rails (parallel to guardrail/handrail or vertical)	40 × 40 × 5 angle	26.9 × 3.2 wt
Toeboards	100 × 6 flat	—

LEGEND:
wt = wall thickness

NOTE: Based on 1000 mm post height and 2400 mm post spacing.

Figure 8 Recommended Material (AS1657-2013)

7 Testing

035 It is recommended that full testing based on AS1657-2013 be conducted on the railing, including its support structure (the platform for example) to determine fitness for purpose. However, it is understood that many such modifications will be “one-off” and detailed calculations or destructive testing is inappropriate. A simplified test procedure is presented below based on AS1657-2013 criteria.

036 The testing outlined in this section is intended to be conducted by the fabricator or machine owner and shall be documented and filed. As the test is simplified, the Pass/Fail criteria is intentionally more conservative than the AS1657-2013 testing.

037 As the platform/tractor is a part of the support structure, undertaking the simplified test requires that the system be fully assembled, and the tractor parked in a safe position on level ground.

7.1 Safety

038 A full and thorough risk assessment should be carried out by the testing personnel prior to any testing process. The guidance contained below is intended to provide structure to this risk assessment and outline a minimum of considerations.

039 When testing any structure, it is important to be mindful that the testing may not be successful, and the energy stored in the straps, handrails and elastically deformed structures can be released unexpectedly. Ensure that all personnel are out of “the line of fire” where the release of energy could endanger them, use barricades and exclusion zones during the test and load the structure progressively to ensure structural competence.

7.2 Equipment

040 The simplified test is intended to be conducted with easily obtainable equipment. Suggested is:

- Spring Balance/Miniature Crane Scales (150kg capable), to measure load applied. A typical spring balance is shown.

Figure 9 Spring balance and Miniature Crane Scale

- Ratchet strap, load rated to ≥200kg. Ensure the strap is in good condition with no damage, cuts or wear.
- Anchor points suitable to loads ≥200kg, to pull against.
- Tape measure, to measure deflection

7.3 Review

041 These test procedures outline a minimum requirement to achieve sufficiently strong handrails and platform structures in compliance with the relevant Australian Standards. The tests are not intended to replace all discretion or accommodate the operational of physiological requirements of the machine. It is a recommended that a formal risk assessment be carried out on all machines to identify other hazards and present methods for the management of these hazards through:

042 Elimination: Removing the hazard or

043 Substitution: Using alternative methods for completing the task that do not expose people to the risks.

044 Engineering: Alter the design to avoid or reduce the risk exposure

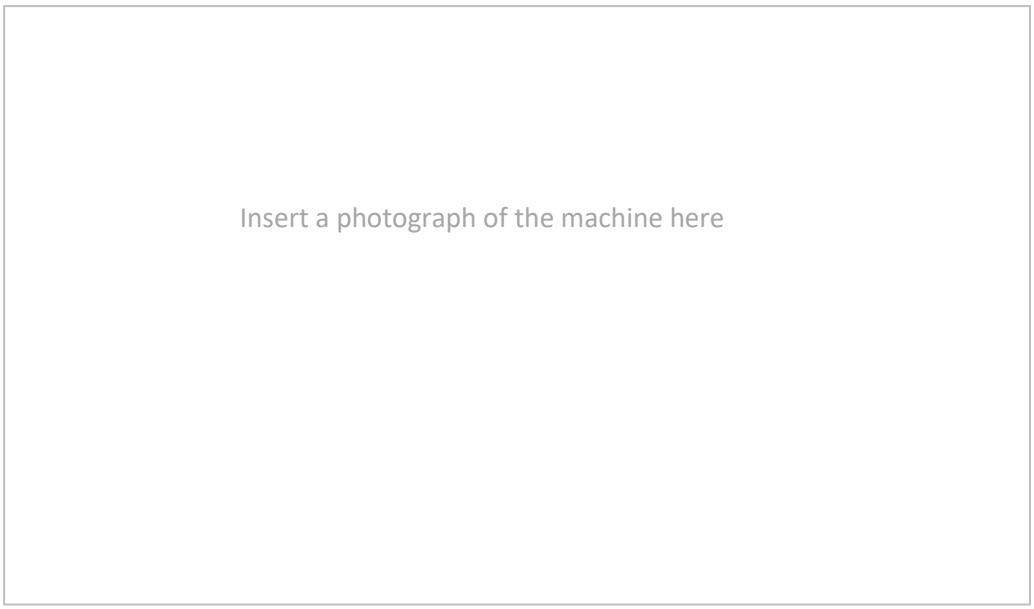
045 Isolation: Separating the hazard from people.

046 Administrative controls: Identify the required operational behaviour to minimise and manages the risk and ensure compliance through training and auditing.

8 Turf Harvester Fall Protection Testing Template

Date:	
Machine Details:	
Identification:	
Testing Location:	
Test Responsible Person:	

Photos of machine under test:



8.1 Test strategy

Test Pre-load: Prior to each test, apply a load equivalent to 50% on the intended test load for 1min, then release. Check against the Pass/fail criteria before continuing to 100% of the specified load.

Permanent deformation is estimated as the difference between the measured displacement before the test stage and the measured displacement after the test stage.

8.2 Rear Handrail

8.2.1 Test 1: Mid-Span Horizontal

Insert a photograph of the test set-up here

1) Record the distance from the top rail to a reference point (not affected by loading)
2) Load the top rail at the mid-span smoothly up to approx. 40kg (30-50kg)
3) Hold load for 1 minute
4) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

If Pass then continue to 5. If fail do not continue any testing on component.

5) Increase load smoothly up to approx. 80kg (70-90kg)
6) Hold load for 1 minute
7) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

8) Remove the load
9) After 1 minute record any permanent deformation

Result (mm)	
Pass/Fail	

A Pass result is less than or equal to 20mm.

Sign	
Date	

8.2.2 Test 2: Mid-Span Vertical

Insert a photograph of the test set-up here

1) Record the distance from the top rail to a reference on the tractor
2) Load the top rail vertically at the mid-span smoothly up to approx. 40kg (30-50kg)
3) Hold load for 1 minute
4) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

If Pass then continue to 5. If fail do not continue any testing on component.

5) Increase load smoothly up to approx. 80kg (70-90kg)
6) Hold load for 1 minute
7) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

8) Remove the load
9) After 1 minute record any permanent deformation

Result (mm)	
Pass/Fail	

A Pass result is less than or equal to 20mm.

Sign	
Date	

8.2.3 Test 3: Post Horizontal

Insert a photograph of the test set-up here

1) Record the distance from the top of the post to a reference on the tractor
2) Load the top of the post vertically at the mid-span smoothly up to approx. 40kg (30-50kg)
3) Hold load for 1 minute
4) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

If Pass then continue to 5. If fail do not continue any testing on component.

5) Increase load smoothly up to approx. 80kg (70-90kg)
6) Hold load for 1 minute
7) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

8) Remove the load
9) After 1 minute record any permanent deformation

Result (mm)	
Pass/Fail	

A Pass result is less than or equal to 20mm.

Sign	
Date	

8.3 Front Handrail

047 All machines shall have a front handrail that is a direct coupling to the non-hinged machine structure. This handrail will be located to provide a safe and robust position for the stacker when traversing rough terrain and should be centred on the platform.

8.3.1 Test 1: Mid-Span Horizontal

Insert a photograph of the test set-up here

1) Record the distance from the handrail reference
2) Load the front hand rail at the mid-span smoothly up to approx. 40kg (30-50kg)
3) Hold load for 1 minute
4) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

If Pass then continue to 5. If fail do not continue any testing on component.

5) Increase load smoothly up to approx. 80kg (70-90kg)
6) Hold load for 1 minute
7) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

8) Remove the load
9) After 1 minute record any permanent deformation

Result (mm)	
Pass/Fail	

A Pass result is less than or equal to 20mm.

Sign	
Date	

8.3.2 Test 2: Mid-Span Vertical

Insert a photograph of the test set-up here

1) Record the distance from the handrail reference
2) Load the front hand rail vertically at the mid-span smoothly up to approx. 40kg (30-50kg)
3) Hold load for 1 minute
4) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

If Pass then continue to 5. If fail do not continue any testing on component.

5) Increase load smoothly up to approx. 80kg (70-90kg)
6) Hold load for 1 minute
7) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

8) Remove the load
9) After 1 minute record any permanent deformation

Result (mm)	
Pass/Fail	

A Pass result is less than or equal to 20mm.

Sign	
Date	

8.4 Driver Access Hand Rail

8.4.1 Test 1: Mid-Span Horizontal

Insert a photograph of the test set-up here

1) Record the distance from the top rail to a reference on the tractor
2) Load the top rail up to approx. 40kg (30-50kg)
3) Hold load for 1 minute
4) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

If Pass then continue to 5. If fail do not continue any testing on component.

5) Increase load smoothly up to approx. 80kg (70-90kg)
6) Hold load for 1 minute
7) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

8) Remove the load
9) After 1 minute record any permanent deformation

Result (mm)	
Pass/Fail	

A Pass result is less than or equal to 20mm.

Sign	
Date	

8.4.2 Test 2: Mid-Span Vertical

Insert a photograph of the test set-up here

1) Record the distance from the handrail to a reference on the tractor
2) Load the top rail vertically at the mid-span smoothly up to approx. 40kg (30-50kg)
3) Hold load for 1 minute
4) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

If Pass then continue to 5. If fail do not continue any testing on component.

5) Increase load smoothly up to approx. 80kg (70-90kg)
6) Hold load for 1 minute
7) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

8) Remove the load
9) After 1 minute record any permanent deformation

Result (mm)	
Pass/Fail	

A Pass result is less than or equal to 20mm.

Sign	
Date	

8.4.3 Test 3: Post Horizontal

Insert a photograph of the test set-up here

1) Record the distance from the handrail to a reference on the tractor
2) Load the top of a post horizontally smoothly up to approx. 40kg (30-50kg)
3) Hold load for 1 minute
4) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

If Pass then continue to 5. If fail do not continue any testing on component.

5) Increase load smoothly up to approx. 80kg (70-90kg)
6) Hold load for 1 minute
7) Measure the deflection at the point of load – by measuring the distance from the top rail to the same reference as in step 1

Measured Load (kg)	
Deformation (mm)	
Result mm/kg	
Pass/Fail	

A Pass result is less than or equal to 1.2mm/kg

8) Remove the load
9) After 1 minute record any permanent deformation

Result (mm)	
Pass/Fail	

A Pass result is less than or equal to 20mm.

Sign	
Date	

8.5 Platform Vertical Load Test

048 The platforms (both the stacker and driver access) shall be able to support a load of 200kg per square meter dynamically. To test this capability:

1) Calculate platform area (Area = Length (m) x width (m))
2) Calculate the load 200kg x Area, with a minimum load of 200kg
3) Load the platform with material such as sand bags, soil, or turf sods, water containers (not people)

Load (kg)	

Insert a photograph of the test set-up here

4) Place vehicle on a level concrete surface
5) Measure the height of the lowest edge of the rear of the platform to the ground using a straight edge on the ground
6) Operate the machine on standard road and surface conditions for a period of 10 minutes
7) Measure the height of the lowest edge of the rear of the platform
8) Permanent deformation is estimated as the difference between the measured height before the test run and the height after the test run

Result (mm)	
Pass (less than 20mm)/Fail	

Sign	
Date	

9 Practical Design Considerations

049 This section presents specific design guidance and practical design requirements based on the inspection of a single modified harvester. These design recommendations may not be relevant to all alternative implementations. It is intended that modifications to other machines consider the ergonomic and structural guidance contained in the is review.

9.1 Platform Details

050 The example harvester that was inspected had a hinged stacker platform, this allowed the rear of the platform to move upwards by approx. 100mm if the stacking platform were to collide with the ground while traversing a dip or slope. This hinge appeared insufficient for the likely loads and as such introduces a weak point in the structure.

Figure 10 Hinge Area of Concern

051 It appears in the operation and configuration of the platform that the outstand of the platform could be reduced l by approximately 100-200mm. This reduction in platform depth could be achieved by:

a) Reducing the depth of the platform to 600mm, from the existing 670mm.
b) Moving the platform forward, so the forward barrier is below the feed tray of the harvester.

Figure 11 Reducing the Length of the Stacking Platform

052 It was noted that the infill had a cut out, this was required for suitable foot placement during stacking operations to bring the body close to the turf roll. It can be seen in Figure 11 that the platform and forward barrier placement allows for a large gap between the platform and the turf roll location and require significant reach forward and/or bending by the stacker. It is possible that the entire platform could be brought forward to bring the stacker closer to the turf.

053 The forward position of the platform would allow the stacker to place a foot under the feed tray when collecting rolls of turf. A clear space of 550mm can be maintained across the walkway as indicated in Figure 11.

054 These modifications would also reduce moment loads to the tractor structure and would bring the stacker closer inline to the rear of the turf pallet, reducing the likelihood of the stacker using this as a point of entry or exit. Which is undesirable due to the lack of fall protection in this area, and the possibility of falling while out of sight of the driver immediately behind the tractor.

9.2 Vertical Platform Support

055 In the machine inspected, the vertical support to the rear of the stacker platform was provided with a strap connection between the overhead counter-levered canopy structure to the hand rail. The strap was required (as opposed to a rigid connection) due to the hinge.

A webbing Cam-strap is used to support the rear of the platform from the overhead canopy structure

Figure 12 Webbing Strap Used for Platform Support

9.2.1 Flexible support

056 If the platform is hinged it is recommended that the rear outside edge (and possibly inside) of the platform be supported by a suitably rated chain to a support structure. Note that load rated (not necessarily lifting rated) chain should be used. A load rating of over 2000kg would provide adequate support for the dynamic structure. As the chain may be used as a hand hold it should be covered to prevent pinching.

Figure 13 Flexible support using chain

9.2.1.1 Limiting Platform Displacement

If the platform is hinged, a displacement limiting method shall be implemented to ensure rotational movement of the platform does not result in potential crush of a person in the stacker position.

9.2.2 Rigid Support

057 If the hinge can be removed, a suitable rigid connection can be made to an overhead beam. An example of a rigid structural connection is presented in Figure 14.

Figure 14 Example Rigid Platform Structure

9.3 Reinforcing

058 All areas of the original structure where the modified platform connects should be considered for reinforcing. On the tractor inspected, cracking and some buckling was observed on the rear wheel guard, it is noted that this is unlikely critical at this time. However, reinforcement to the tractors structure is advised.

Figure 15 Cracking and reinforcing of rear wheel guard

9.4 Fatigue Cracking

059 On the machine inspected a number of fatigue cracks were observed in the connection between the platform and the tractor. These areas are critical in the support of the platform and all such areas should be inspected for cracks at least monthly.

060 If the canopy structure is used to support the platform this structure should be subjected to the same inspection and repair protocol.

061 Where cracks are observed to be growing they should be repaired immediately.

062 Any area with repeated cracking should be improved to provide sufficient operational life (at least 12 months) without requiring repair.

063 Note: areas that have experienced rapid fatigue crack growth are likely to contain a number of crack initiation points and the replacement of the structural member is considered preferential in any repair.

9.5 Machine Inspection Records

064 Records of all machine inspections will include

- Date of inspection
- Machine identity
- A drawing or photograph of the machine that is marked with cracks detected
- A length of any crack identified and photograph if possible
- Identify last inspection date and any change in the identified crack
- Clear guidance on the requirement for and timing of any repair

065 Machines with known faults should not be operated without a risk assessment. The intent of this process is to allow machines to operate with a cracked mudguard but prevent operation of machines with large growing cracks in structural members.