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NEW ZEALAND AGRICULTURAL ENGINEERING INSTITUTE

Lincoln College

PUBLIC TEST REPORT No. T/3

FERGTRAC SAFETY FRAME FOR FERGUSON TEA-20 TRACTORS

SEPTEMBER, 1966

Lincoln College

University of Canterbury

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FERGTRAC SAFETY FRAME FOR FERGUSON TEA-20 TRACTORS: STRENGTH CHARACTERISTICS

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FERGTRAC SAFETY FRAME FOR FERGUSON TEA-20 TRACTORS: STRENGTH CHARACTERISTICS

ENTRANT: C.B. Norwood Ltd, Wellington

MANUFACTURER: J.C. Davidson Ltd, Pahiatua

SUMMARY

Strength tests were made using testing apparatus similar to that used by the National Swedish Testing Institute for Agricultural Machinery and the National Institute of Agricultural Engineering, Silsoe, England to establish whether or not the safety frame is of adequate strength to prevent excessive deformation in the event of an overturning accident. The deflections of this frame during impact and crushing tests were within satisfactory limits.

The frame did not unduly affect accessibility, visibility or maintenance, but noise caused by the vibration of the removable front brace was annoying.

BRIEF DESCRIPTION

The Fergtrac safety frame for Ferguson TEA-20 tractors consists of two U-frames mounted transversely on the tractor; one on the rear axle housing mounting points, and the other on a beam suitably bolted to the front of the bell housing. Two further members are positioned parallel to the longitudinal axis of the tractor and are bolted to the upper four corners of the U-frames by a total of eight U-bolts.

The structural members of the frame are all ex $1\frac{1}{2}$ in nominal bore, 0·160 in (8 s.w.g.) tube. Further details and measurements are given in Appendix I.

For the test, the frame without any form of weather cladding, was fitted to a Ferguson TEA-20 tractor serial number SJ120589 mounted on 11-28 rear tires set at a 52 in track.

SCOPE OF TEST

The primary object of the test was to establish whether or not the safety frame is strong enough to prevent excessive deformation during an overturning accident. Observations of the strength of the frame and attaching brackets were based on impact and crushing tests using a special test rig. Features which might affect the driver or restrict the use of the tractor with the frame fitted, were briefly investigated.

It should be noted that this test procedure makes no attempt to assess any anti-roll characteristics which the frame may possess.

TEST RESULTS

Impact and Crushing Tests - For these tests the frame was fitted to the tractor and the tractor was anchored to a concrete base. The frame was subjected to two impact tests, the first from the rear and the second from the side. In each case the blow was imparted by

a pendulum of mass 4410 lb swinging so that the arc traced out by its centre of gravity was tangential to the horizontal plane containing the upper frame members. The energy applied by the blow was calculated in accordance with the procedure used by the National Swedish Testing Institute for Agricultural Machinery as detailed in Appendix II. The weight of a Ferguson TEA-20 tractor with water ballast in the rear tires - 3180 lbf - was used to calculate the impact energy, which was 2225 ft lbf for the blow from the rear and 4990 ft lbf for the blow from the side. The blows from rear and side were directed respectively along the longitudinal centre line, and 9 in forward of the transverse centre line of the top of the frame.

A uniformly distributed crushing load equal to twice the weight of the tractor - 6360 lbf - was applied to the top of the frame using hydraulic rams and a beam placed on bearers resting on the front and rear top cross members.

Measurements were made before and after the tests to establish the deformation of the frame. The following figures give the average deformations, measured at a height of $37\frac{1}{2}$ in from the loaded tractor seat at the completion of each phase of the test, and indicate the deflection of the frame in the direction of the loading:-

(a) Impact from rear - Mean forward deflection $3\frac{1}{8}$ in

(b) Impact from side - Sideways deflection - rear 7 in

front $6\frac{3}{8}$ in

(c) Static loading - $\frac{1}{4}$ in vertically downwards measured from the deformed position of the frame after the second impact test.

No failure of welds, joints, or mounting attachments took place, but during the sideways impact the engine block casting cracked across the top mounting bolt hole on the opposite side of the tractor from which the blow was struck.

These deformations are considered to be within acceptable limits as detailed in Appendix III and the results of the test can be considered to apply to this frame only when fitted to Ferguson TEA-20 tractors.

COMMENTS ON GENERAL FEATURES

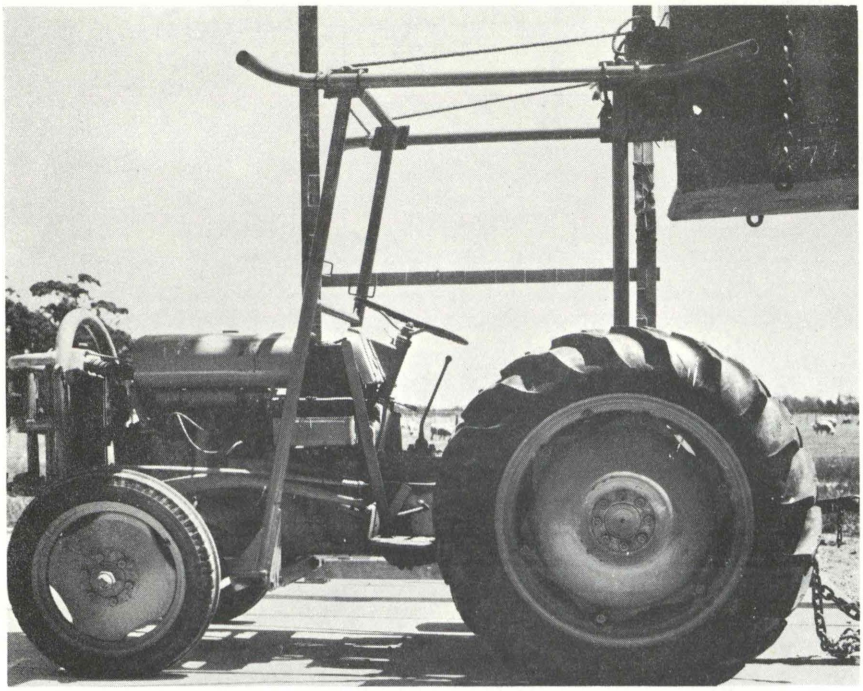
Visibility was not unduly impaired and the frame and mountings did not interfere with the general maintenance of the tractor.

Noise resulting from vibration of the removable cross brace and its pins was considerable, and would be very irritating if the driver was subjected to it for any length of time.[1] Apart from this however the presence of the frame did not significantly increase the noise level to which the driver was subjected.

JOHN R. BURTON
Director.

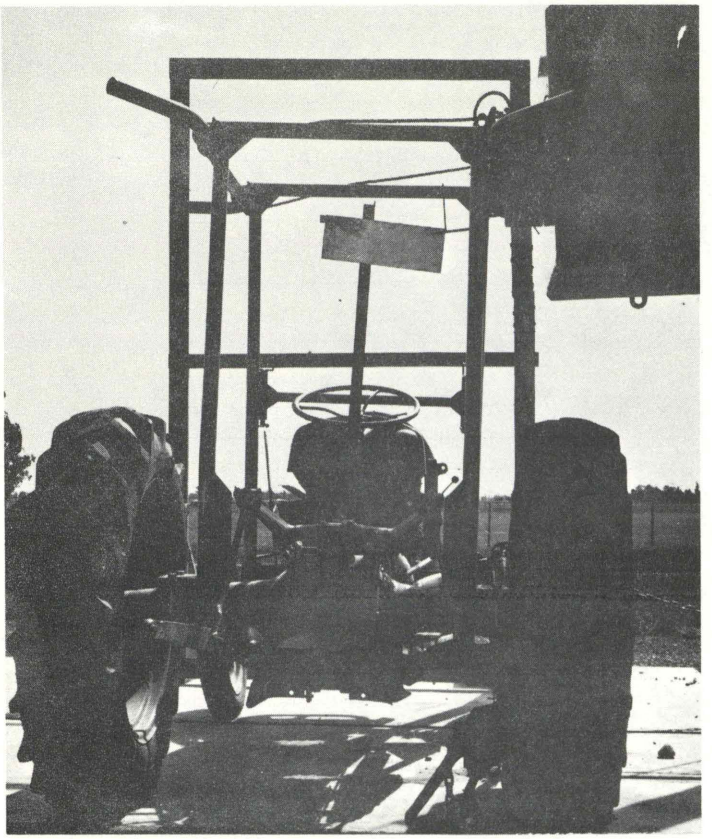
G.M. GARDEN
Testing Officer.
September 1966.

1. Note: The test entrant has advised that a modification aimed at reducing this vibration is under investigation.



Fergtrac safety frame before impact from rear.

Fergtrac safety frame after impact from rear.



Fergtrac safety frame before sideways blow.

Fergtrac safety frame after sideways blow.

APPENDIX I

BRIEF SPECIFICATION OF FRAME AS TESTED WHEN FITTED TO A FERGUSON TEA-20 TRACTOR

The following specification refers only to the safety frame without additional components to provide weather protection.

The frame consists of four uprights ex $1\frac{1}{2}$ in nominal bore 0.160 in (8 s.w.g.) tube. A $\frac{1}{2}$ in thick plate is welded normal to one end of two of these uprights, and each plate is in turn bolted by two $\frac{5}{8}$ in diameter high tensile bolts to the rear axle housing mounting pad beneath the mudguard supporting bracket. Each upright is located on the rear axle centre line $3\frac{1}{2}$ in inside the mounting bolt holes, and is gusseted to the mounting plate by three 12 x 2 x $\frac{1}{4}$ in plates welded vertically to the back, front, and inside of each upright. A $\frac{1}{2}$ in spacer is necessary under the mounting plate to keep it clear of the axle housing, inboard from the mounting pad.

A 35 in length of 5 x $2\frac{1}{2}$ in channel which has suitable lugs welded to it for the purpose, is bolted transversely, web uppermost, to the periphery of the bell housing by six $\frac{3}{8}$ in diameter bolts. The channel is also stiffened at its centre by welding across the flanges a piece of $\frac{1}{4}$ in plate 15 in long. To support the two remaining uprights, each has welded to one end, two brackets which are bolted to the channel section by three $\frac{5}{8}$ in diameter UNF high tensile bolts. One bracket of 2 x $\frac{1}{2}$ in flat is welded to the bottom of the upright and is bolted to the web with one bolt. The other bracket ex 5/16 in plate is welded to the rear of the upright and is attached to the rear flange of the channel by two bolts. A gusset ex 5/16 in plate is welded between the upright and the bracket which is bolted to the channel web. The uprights are so mounted on the channel that they are parallel to a

vertical plane through the longitudinal axis of the tractor, but are leaning at their upper ends towards the rear of the tractor.

The front and rear pairs of uprights are each joined by welding to their upper ends a suitable length of 1½ in nominal bore 0·160 in (8 s.w.g.) tube. A small gusset ex 5/16 in flat is welded in each corner so formed.

The two front uprights are connected just above the bonnet by a removable stay. This is fabricated from a length of 1½ in o.d. tube, which has welded normal to each end and gusseted to it, a 4 in length of 1¼ in o.d. tube of 0·25 in wall thickness. Two short lengths of 1¼ in o.d. 0·25 in wall tube are welded vertically, 4 in apart, to the inside of each upright, and when the ends of the stay are placed between these, a suitable pin is dropped through the three lengths of tube to form a hinge joint.

On each side of the frame, a 72 in length of 1½ in nominal bore 0·160 in (8 s.w.g.) tube is clamped horizontally to the outside of the front and rear uprights by two ½ in diameter U-bolts on each upright. Each U-bolt is bolted to a short length of ⅜ in flat containing two ½ in diameter clearance holes spaced 2½ in apart. Two of these plates are welded to the top of each upright and lie in a vertical plane parallel to the longitudinal axis of the tractor. The ends of each tube are bent outwards in a horizontal plane, and each is prevented from rotating or sliding axially by suitable stops welded to it in the vicinity of the U-bolts.

All material used in the frame is mild steel unless otherwise stated.

DIMENSIONS

Interior width	Rear	29 in
	Front	$31\frac{1}{4}$ in
Minimum distance from steering wheel rim to frame		$2\frac{1}{2}$ in
Height to plane of underside of top frame members from loaded seat (165 lbf)		41 in
Height to plane of underside of top frame members from footplates		$59\frac{1}{4}$ in
Overall height of tractor and frame		$79\frac{1}{2}$ in
Maximum width of frame		$58\frac{1}{4}$ in
Maximum distance frame projects behind rear axle		$16\frac{1}{2}$ in

APPENDIX II

INTERIM SCHEME OF TEST FOR TRACTOR SAFETY FRAMES (D.ST 65/1).

1. PURPOSE OF TEST

This Scheme of Test is primarily intended for the purpose of measuring the strength characteristics of a tractor safety frame and its mountings. It also provides for an evaluation of the effects of the frame on the operation of the tractor to which it is mounted. This Scheme of Test does not include any evaluation of the anti-rolling characteristics of a safety frame.

2. VALIDITY OF TEST RESULTS

The results of this test are considered to apply only to the tractor/safety frame combination on which it was carried out and to identical tractor/safety frame combinations in which the frame has been fitted strictly in accordance with the manufacturer's specification. It might also, subject to the written opinion of the Director of the Institute, be considered to apply to combinations of an identical safety frame with tractors of the same manufacturer's range having identical mounting points and a lower all-up weight than the tractor tested.

3. TEST PROCEDURE

The following tests will be conducted:-

(i) Strength tests

(ii) Noise test

(iii) General evaluation

Details of these tests are as follows:-

3.1 Strength Tests

The strength of the safety frame and its mountings will be determined by conducting the three tests detailed below, which will be carried out on one and the same cab in the order given. No repairs or adjustments will be allowed between successive tests.

a. Rearwards impact test: The rearwards impact test will be applied by causing a pendulum of mass 4410 lb to strike the frame from the rear at a position and in a direction appropriate to the manner in which the frame can be expected to contact the ground in the event of overturning rearwards.

The impact energy applied will be equivalent to 1810 + 0·13 W ft lbf where W is the weight of the tractor in pounds force. During the test the tractor will be firmly fixed to the ground.

b. Sideways impact test: The sideways impact test will be applied by causing a pendulum of mass 4410 lb to strike the frame from the side at a position and in a direction appropriate to the manner in which the frame can be expected to contact the ground in the event of the tractor overturning sideways.

The impact energy applied will be equivalent to 1810 + 1·0 W ft lbf where W is the weight of the tractor in pounds force. During the test the tractor will be firmly fixed to the ground.

c. Compression test: A static compression test will be applied vertically to the frame over that part of it which is most likely to support the tractor if it rolls through 180°. A load of 2·0 W lbf will be applied, where W is the weight of the tractor in pounds force. During the test the tractor will be supported from beneath in such a way that the load is not transmitted to its wheels.

The points at which the impact and compression tests will be applied to the frame and the manner of fixing or supporting the tractor will be decided by agreement between the testing officer and the test entrant. In the event of any disagreement the ruling of the Director of the Institute shall be final.

3.2 Noise Test

Noise level measurements will be made on the same tractor both with and without the safety frame or cab under identical working conditions, as agreed between the Director and the test entrant.

3.3 General Evaluation

The tractor/safety frame combination will be operated by staff of the Institute under selected conditions. The following points will be commented upon in the test report:-

a. Convenience of access
b. Visibility
c. Roominess and convenience of operation
d. Effect on operation of tractor controls
e. Effect on operation of trailed or mounted implements
f. Effect on maintenance of tractor
g. Noise, heat, fumes and driver fatigue.

4. PUBLICATION AND USE OF TEST RESULTS

Attention is drawn to Clauses 12, 13, 14, 15, 17, 18, and 19 of the Institute's Interim Testing Regulations for Test of Production Safety Devices for Agricultural Machinery.

APPENDIX III

Interpretation of Strength Tests

At the date of publication of this report no specific limits on the allowable deformation of safety frames subjected to the impact and compression tests described in this report have been laid down for New Zealand conditions.

Following an exhaustive analysis of all available overseas data and a careful evaluation of experience with safety frame testing at Lincoln College, the Institute holds the view that a safety frame cannot be considered to have satisfactory strength characteristics if the deformation measured after each impact described in Appendix II exceeds,

(a) Impact from rear - four (4·0) inches forwards

(b) Impact from side - ten (10·0) inches sideways