Test Report

IPS 7898-80

ISTA 3E PERFORMANCE TEST

DRUMCLIP DC18A RED
with
TIGHT HEAD BARREL DRUMS

The IPS-report may be released for viewing to relevant parties.

IPS Technology is an independent packaging and tooling design agency. Aside from designing IPS also performs research, delivers advice on packaging issues and performs packaging test in its own test facility.

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Reference	:	IPS 7898 - 80
Description	:	Test Report ISTA 3E Drumclip DC18A Red with Tight Head Barrel Drums
Date	:	August 19. 2019
Author(s)	:	Marten Ries
Client	:	Geba Innovations B.V. Chr. Huygensstraat 3 3261 LR Oud-Beijerland The Netherlands
Contacts	:	Wouter Geldhof
Test performed by	:	Marten Ries
Test Date(s)	:	August 16, 2019
Test Facility	:	IPS Technology, Eindhoven The Netherlands ISTA Certified Testing Laboratory, Member ID: 9778 (Appendix A)

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1. Scope of test

The goal of this transport simulation test, performed according to the ISTA 3E-2017 Standard for Unitized Loads, is to validate the capability of the Drumclip system for sufficient load stability subjected to rough mechanical handling; forklift truck handling and warehousing stacking.

Four Standard Tight Head Barrel Drums 200L are placed on a pallet and secured with two Drumpclips and secured with two polyester lashings.

Securing of the pallets during Full Truckload (FTL) will be done with help of strapping belts and is not in scope of this test.

Figure 1. Test configuration

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Details of tested configuration:

The tested configuration is built up with components listed below:

Item	Remark
Standard Tight Head Barrel Drums 200L. Quantity: 4	Drums fully filled with water. Used condition.
Pallet type: CP-9	Chemie Pallet,1140x1140x156mm, used condition.
Lashing: Signode Tenax 2040 Strapping. Quantity: 2	Polyester Strapping 16mm, thickness 0,89mm Location of the strapping shown in Figure 1.
Drumpclip type: DC18A RED	Quantity used: 2x

Lashing is assembled with Plastic Strapping Handtool: Strapex STB75.
Pre-tension on strapping: 2100N, Weldingtime level: 4

Parameter	Value
Total mass DUT:	892 kg
Dimensions:	1170x1170x1030mm (LxWxH).
Sample Numbers to be tested:	1

Remark:
The drums are exceeding the base dimensions of the pallet.
The Tenax strapping will be applied just before the execution of the test program.

Identification of sides (according to ISTA 3E) see Figure 2.

Figure 2. Faces of DUT identified.

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2. Product Damage Tolerance and Package Degradation Allowance

The product will be tested in the prepared configuration. Replacement of components of DUT is not allowed.

Product Damage Allowance:
During horizontal impact tests the drums will impact the ridged wall of the Horizontal Impact Tester. The drums are exceeding the dimensions of the pallet base.
It will we expected that damage to the drums cannot be avoided during the executing of this tests. Damage to the drums caused by this impacts is within the allowance criteria.

Package Degradation Allowance:
During and after the test the integrity of the DUT must be guaranteed.

- All drums are placed on the pallet bottom during and after the execution of the test.
- The forklift truck can interface the pallet during and after the execution of the test.
- The Drumclip is not broken-heavily damaged (validation by Geba Innovations)

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3. Test plan

The test plan is based on the ISTA 3E -2017 procedure.

According ISTA 3E the test sequence will be executed as stated in the table below.

Performance Test Schedule	***Description***	***Note***
1st	Atmospheric preconditioning	Ambient level
2nd	Shock; horizontal impact	1,2 m/s
3rd	Shock: rotational edge drop	Drop height 150mm
4th	Compression	Apply and release method
5th	Vibration: random	Overall Grms= 0.54
6th	Shock: rotational edge drop	Drop height 150mm

3.1 Atmospheric Conditioning

The sample will be conditioned to ambient laboratory level.

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3.2 Shock; horizontal impact 1,2ms

The DUT will be exposed to horizontal impacts in order and under the conditions as stated in the table below.

Sequence No.	***Specific Face***	***Impact Speed***
1	Face 6	1,2 m/s
2	Face 5	1,2 m/s
3	Face 2	1,2 m/s
4	Face 4	1,2 m/s

Horizontal impact testing will be performed with the IPS Technology horizontal impact tester.

Specifications of the horizontal impact tester can be found in Appendix B.

Figure 3.DUT on horizontal impact tester.

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3.3 *Shock; 1st Rotational Edge Drop*

Based on the mass of the DUT >230kg the drop height is set on 150mm.
During the drop test, the side opposite to the drop side is supported by a timber with a height of 90mm.
The DUT is exposed to rotational edge drops in order and under the conditions according to the table below.

Sequence No.	***Specific edge***	***Drop height***
1	Edge 3-6	150mm
2	Edge 3-2	150 mm
3	Edge 3-5	150 mm

Figure 4. Set-up Rotational Edge Drop Test

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3.4 Compression Test; Machine Apply and Release

The DUT will be exposed to a; 'Machine Apply and Release' compression test according to the ISTA 3E test protocol. For the calculation for compression (Apply and Release method) the formula AR = {[Wt x (S-1) +(Wt/L) x (L-1)] x F – (Wt / L) (L-1)} x 1,4 x 9,8 is applicable.

Wt	Total weight of packaged product (Kilograms)	892 Kg	
S	Total number of potential unitized loads in a warehouse stack or a vehicle stack	4	Including the bottom unitized load
L	Total number of layers in the unitized load	1	
F	Compensating factor	3	Typical compensating factor
9,8	Metric conversion factor	9,8	
1,4	Factor to account for time of compression	1,4	
AR	Result of calculation: Test Load for Apply and Release (Newton)	36.793 N	= 3750 Kg

The test will be performed with an additional (empty) pallet on top of the DUT. This will be done in order to simulate the reality of stacking load. Figure is showing the compression test setup.

Figure 5. Test set-up Compression Test

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3.5 Vibration; ISTA Steel Spring Truck Random Vibration

The DUT will be exposed to a vibration test without compressive load, to simulate transport vibrations. The test is performed under 'loose load' conditions. For the test setup see Figure .
The during of 60minutes will be equivalent to a transport of 480km.

Orientation	***Vibration Profile acc.***	***Duration***
Face 3 down (bottom face)	ISTA Steel Spring Truck	60 minutes

Specifications of the vibration test equipment can be found in Appendix C.

The Power Spectral Densities ISTA Steel Spring Truck profile is given in the figure below.

Frequency (Hz)	PSD Level, g^2/Hz
1.0	0.00072
3.0	0.018
4.0	0.018
6.0	0.00072
12.0	0.00072
16.0	0.0036
25.0	0.0036
30.0	0.00072
40.0	0.0036
80.0	0.0036
100.0	0.00036
200.0	0.000018

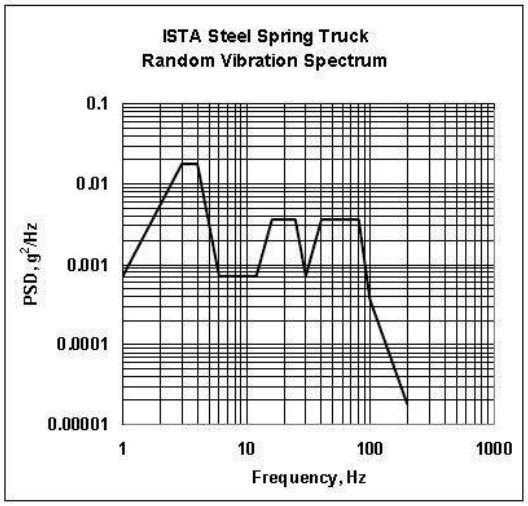

Figure 2. Power Spectral Densities – Steel Spring Truck Random Vibration

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Figure 6. Test setup for vibration test

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3.6 Shock; 2nd Rotational Edge Drop

Based on the mass of the DUT >230kg the drop height is set on 150mm.
During the drop test, the side opposite to the drop side is supported by a timber with a height of 90mm.
The DUT is exposed to rotational edge drops in order and under the conditions according to the table below.

Sequence No.	***Specific edge***	***Drop height***
1	Edge 3-6	150mm
2	Edge 3-2	150 mm
3	Edge 3-5	150 mm

Figure 7. Set-up Rotational Edge Drop Test

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4. Test Results

The tests are executed according to test plan. In the following chapters the test results can be found per test.

4.1 Atmospheric Conditioning

The DUT has been conditioned to ambient laboratory level.

4.2 Shock; Horizontal Impact

The horizontal impact test is executed according test plan. No remarkable event occurred before, during or after performance of this Test Sequence. The impact speed is measured at 1,2 m/s. See for the speed graph Appendix D.

4.3 Shock; 1 Rotational Edge Drop

The Rotational Edge Drop Sequence is executed according test plan. No remarkable event occurred before, during or after performance of this Test Sequence.

4.4 Compression; Machine Apply and Release

No remarkable event occurred before, during or after the Test Sequence.
A screenshot of the compression test is shown in a graph in Appendix E.

4.5 Vibration; ISTA Steel Spring Truck Random Vibration

The vibration test is executed according test plan. No remarkable event occurred before, during or after performance of this Test Sequence. A screenshot of the PSD during the test is shown in Appendix F.

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4.6 Shock; 2nd Rotational Edge Drop

The Rotational Edge Drop Sequence is executed according test plan. No remarkable event occurred before, during or after performance of this Test Sequence.

5. Inspection after test

After execution of the complete test cycle no remarkable – unexpected damages to the DUT and it components could be found. The expected damage to the drums could be found on only on face 4. The condition of the CP-9 pallet was still in useable condition.

Figure 8. Damage to drums; only face 4.

Examination of the condition by personnel of Geba Innovations B.V.of the Drumclips after the test showed no visible damage or wear.

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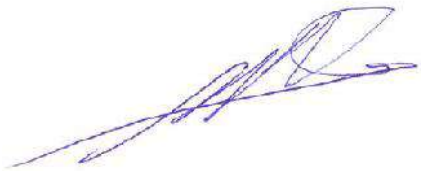
6. Conclusions

The test has been executed according to the test plan.
No remarkable-unexpected events and/or damage has occurred before, during or after the test to the DUT.

The Drumclip system in combination with the defined lashing configuration is fully capable to ensure safe individual pallet mechanical pallet handling and warehouse stacking.

Eindhoven, August 20, 2019

Checked and approved by:



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Appendix A. ISTA Certified Testing Laboratory

Figure 9. IPS Technology ISTA Laboratory Certification

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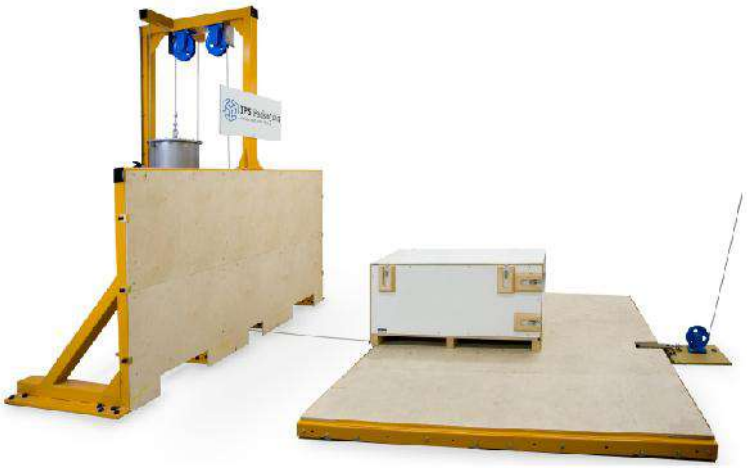
Appendix B. Test Equipment: Impact Tester



Fabrikant
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Oppervlakte
245x250 cm

Max. productmassa
1300 kg

Opspanning
Horizontaal

Botssnelheden
2-10 km/h

Datalogging
Snelheidsmeetsysteem registreert de snelheid bij botsing

Optioneel
Versnellingsmetingen aan het product met een drie-assige versnellingsopnemer

Normen (o.a.):
ASTM D 5487
ISO 2244

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Appendix C. Test Equipment: Shaker

- Manufacturer : Lansmont model 10000 TTV II
- Max. specimen size : 152 x 152 cm
- Max. specimen weight : 2200 kg
- Max. amplitude (peak to peak) : 6,4 cm
- Frequency-range : 3 - 300 Hz
- Frequency-rang at max. load : 3 - 200 Hz
- Acceleration range : 0 - 8 g
- Max. acceleration at max. load : 2 g
- Automatic displacement or acceleration control
- Automatic sweep generator and random vibration facilities (Lansmont TouchTest Vibration system)
- Accelerometer

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Appendix D. Impact speed

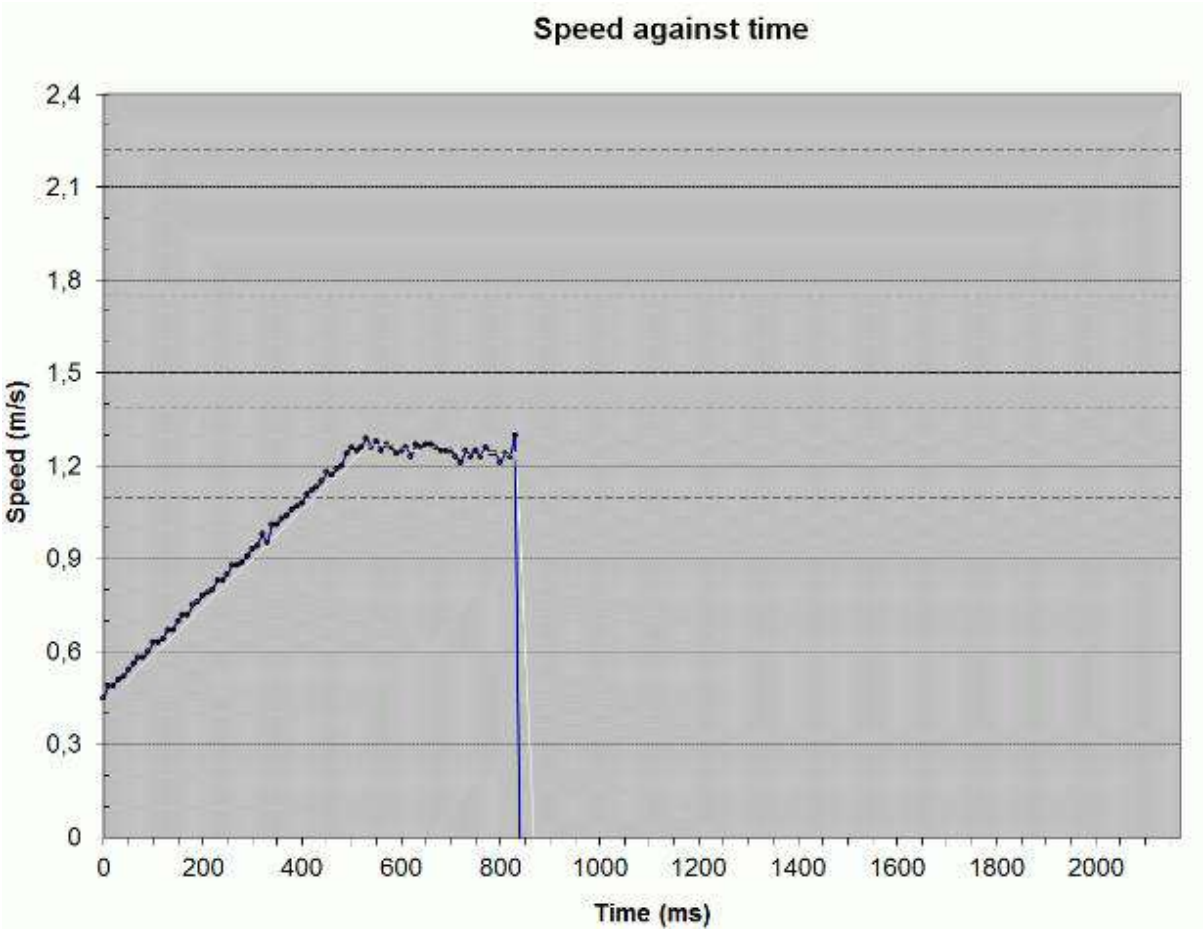

Figure 10. Impact speed >1,2m/s

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Appendix E. Compression test graph

TouchTest Compression

Lansmont

Sample ID	Peak Force (kg)	Defl @ Pk (cm)	PreLoad (kg)	Test Speed (cm/min)	Temp (deg C)	%RH	Time	Date
ISTA 3E DRUMCLIP SAMPLE DC18A RED #2	3757	1.61	22.0	1.30	19.8	64.7	11:19 AM	16-Aug-19

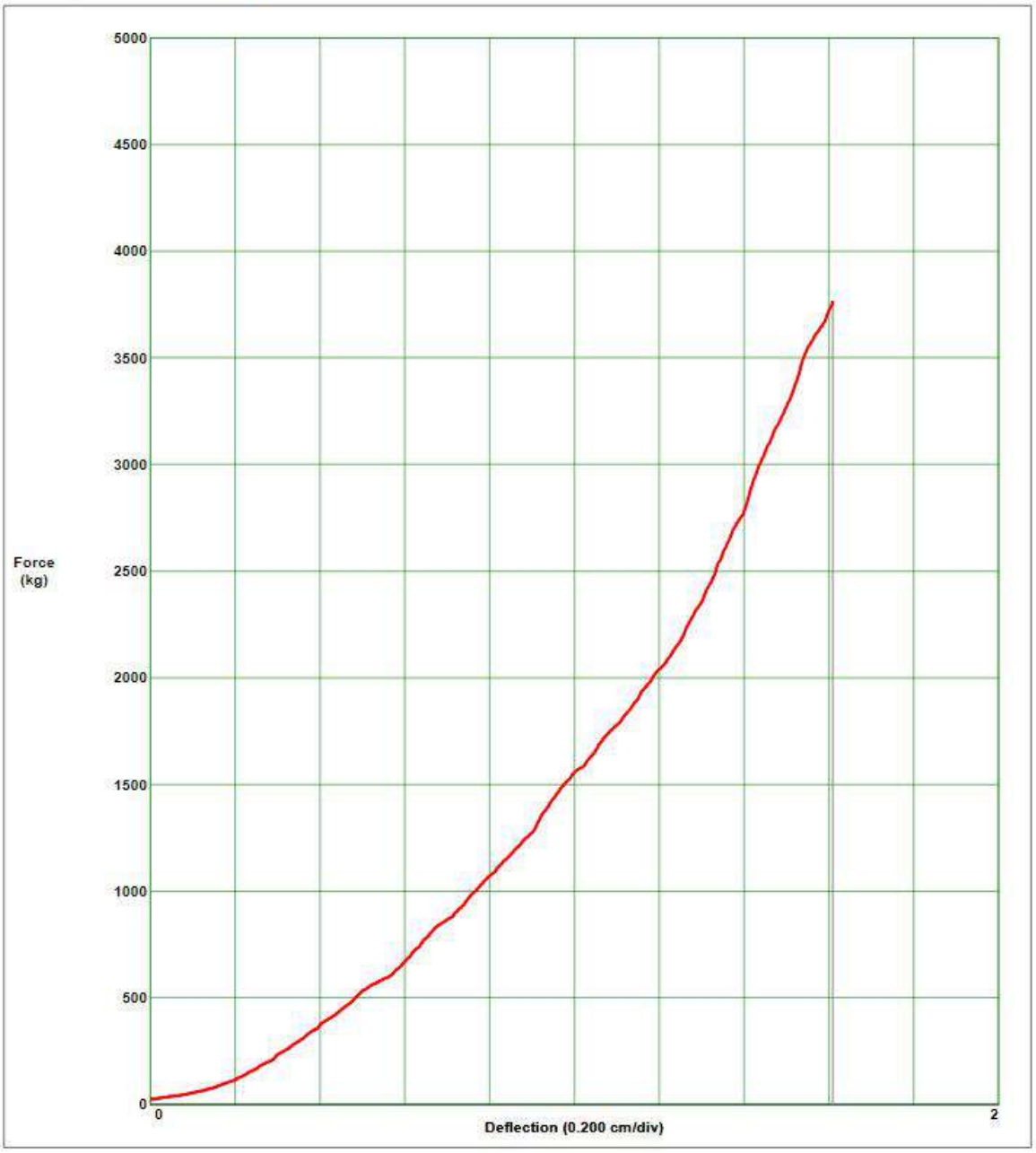

Figure 11. Compression test graph – Apply and release compression test

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Appendix F. Power Spectral Densities Profile

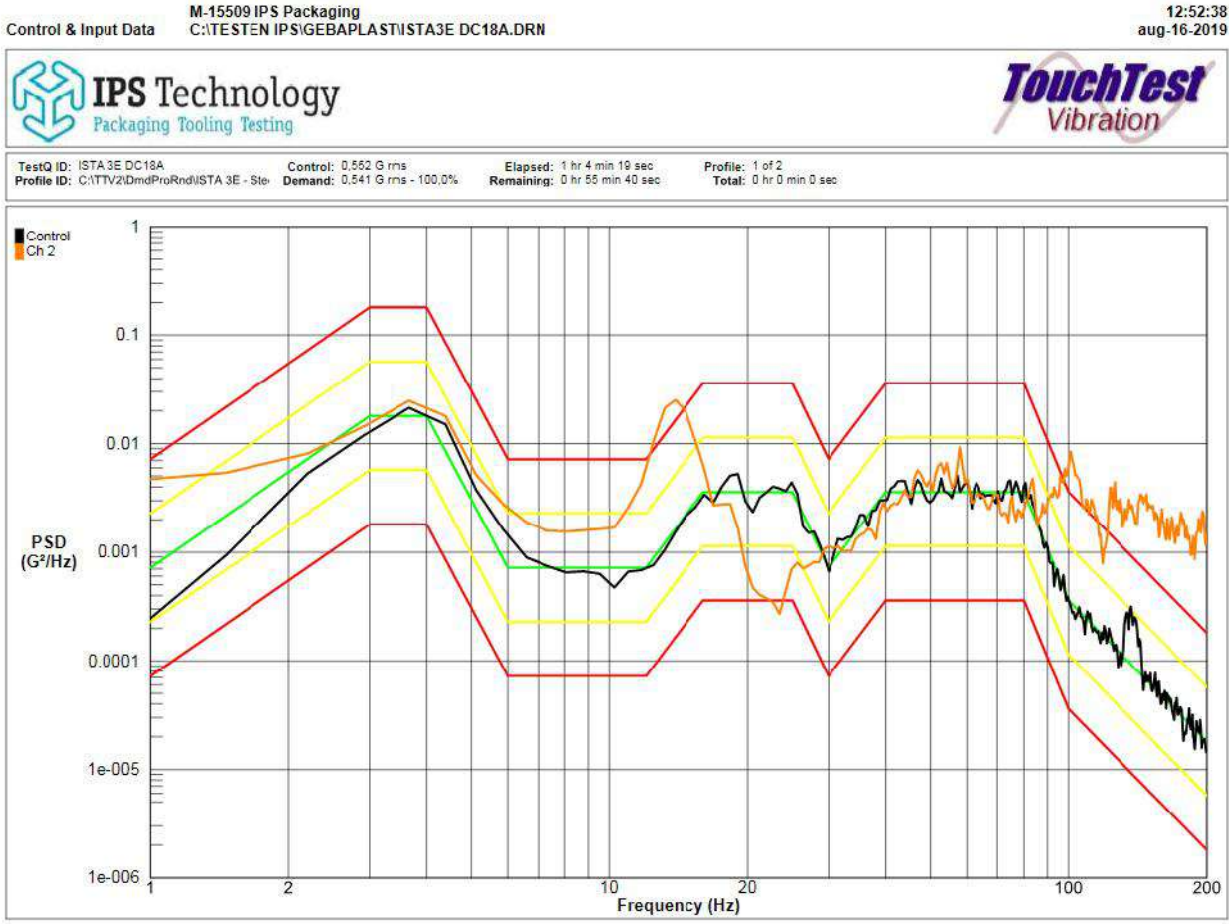

Figure 12. Power Spectral Densities - ISTA Steel Spring Truck Random Vibration; 1 hr 4min.

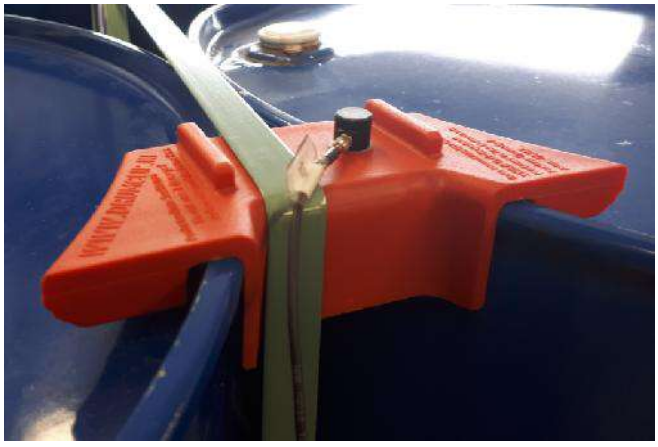

Figure 13. Location accelerometer Ch2. for response monitoring (examination only)

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