

**Vehicle Research and Test Center
2001 Ford Taurus
Roof Crush Research
with 5° Pitch, 25° Roll
TRC Inc. Test Number: F030915**

**Prepared By:
Transportation Research Center Inc.
10820 State Route 347
East Liberty, OH 43319**

**Final Report
September - October 2003**

**Prepared For:
Vehicle Research and Test Center
P. O. Box 37
East Liberty, OH 43319**

Notice

Transportation Research Center Inc. does not endorse or certify products of manufacturers. The manufacturer's name appears solely to identify the test article. Transportation Research Center Inc. assumes no liability for the report or use thereof. It is responsible for the facts and the accuracy of the data presented herein. This report does not constitute a standard, specification, or regulation.

This publication is distributed by the U. S. Department of Transportation, National Highway Traffic Safety Administration, in the interest of information exchange. The opinions, findings and conclusions expressed in this publication are those of the author(s) and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof. If trade or manufacturers' names or products are mentioned, it is only because they are considered essential to the object of the publication and should not be construed as an endorsement. The United State Government does not endorse products or manufacturers.

Table of Contents

<u>Section</u>	<u>Description</u>	<u>Page</u>
1.0	Purpose and Test Procedure	1-1
2.0	Roof Crush Resistance Test Summary	2-1
Appendix A	Photographs	A-1
Appendix B	Data Plots	B-1
Appendix C	Test Instrument Calibration Information	C-1

List of Tables

<u>Number</u>	<u>Description</u>	<u>Page</u>
1	Test Vehicle Information	2-4
2	Pre-Test Preparation and Test Parameters	2-6
3	Test Results	2-8

List of Figures

<u>Number</u>	<u>Description</u>	<u>Page</u>
1	Vehicle Transducer Placement	2-7

List of Photographs

<u>Photograph Title</u>	<u>Figure</u>
Pre Test Front - View 1	A-1
Pre Test Front - View 2	A-2
Pre-Test Left Front Angle View	A-3
Pre-Test Left Side View	A-4
Pre-Test Left Rear Angle View	A-5
Pre-Test Rear View	A-6
Pre-Test Right Side View	A-7
Pre-Test Dummy Front View	A-8
Pre-Test Dummy Left Front Angle View	A-9
Pre-Test Dummy Left Side View	A-10
Pre-Test Dummy Right Side View	A-11
Pre-Test Loading Device Initial Contact Point View	A-12
Pre-Test Left Front Stand and Reinforcement View	A-13
Pre-Test Left Rear Stand and Reinforcement View	A-14
Pre-Test Right Front Stand and Reinforcement View	A-15
Pre-Test Right Rear Stand and Reinforcement View	A-16
Pre-Test Left Front Displacement Potentiometer View	A-17
Pre-Test Left Rear Displacement Potentiometer View	A-18
Pre-Test Right Front Displacement Potentiometer View	A-19
Pre-Test Right Rear Displacement Potentiometer View	A-20
Pre-Test Opposite Side Lateral Displacement Potentiometer View	A-21
Pre-Test Interior Roof View	A-22
Post-Test Maximum Stroke Front View	A-23
Post-Test Front - View 1	A-24
Post-Test Front - View 2	A-25
Post-Test Left Front Angle View	A-26
Post-Test Left Side View	A-27
Post-Test Left Rear Angle View	A-28

List of Photographs, Cont'd.

<u>Photograph Title</u>	<u>Figure</u>
Post-Test Rear View	A-29
Post-Test Right Side View	A-30
Post-Test Dummy Front View	A-31
Post-Test Dummy Left Side View	A-32
Post-Test Dummy Right Side – View 1	A-33
Post-Test Dummy Right Side – View 2	A-34
Post-Test Vehicle Damage - View 1	A-35
Post-Test Vehicle Damage - View 2	A-36
Post-Test Vehicle Damage - View 3	A-37
Post-Test Vehicle Damage - View 4	A-38
Post-Test Vehicle Damage - View 5	A-39
Post-Test Vehicle Damage - View 6	A-40
Post-Test Left Front Stand and Reinforcement View	A-41
Post-Test Left Rear Stand and Reinforcement View	A-42
Post-Test Right Front Stand and Reinforcement View	A-43
Post-Test Right Rear Stand and Reinforcement View	A-44
Post-Test Interior Roof – View 1	A-45
Post-Test Interior Roof – View 2	A-46
Vehicle Certification / Tire Information Label	A-47

Section 1.0

Purpose and Test Procedure

Purpose

This roof crush resistance test is a part of the test program conducted for the National Highway Traffic Safety Administration (NHTSA) Vehicle Research and Test Center (VRTC) by Transportation Research Center Inc. (TRC). The purpose of these tests is to evaluate potential new test procedures and performance requirements for FMVSS 216 and to evaluate the roof crush performance of recent model year vehicles. The subject vehicle of this test was a 2001 Ford Taurus 4-door sedan.

Test Procedure

These tests were conducted in accordance with instructions from VRTC to modify procedures for FMVSS 216, roof crush testing. Data was obtained relative to roof crush resistance performance and vehicle motion during the test procedure.

A Part 572B 50th male dummy torso was positioned in the drivers seat. A contact switch was attached to the dummy's head, which fired a strobe light to indicate the time the head made contact with the interior roof liner.

The test vehicle was subjected to a 254 mm (10-inch) stroke of the loading device, not to exceed a 60,000 N load. The load was applied to the left forward edge of the vehicle roof. A flat rectangular rigid loading device 30 inches wide by 72 inches long was used to apply the load. The loading device was oriented with its longitudinal axis at a forward angle of 5° below the horizontal and parallel to a vertical plane through the vehicle longitudinal centerline. The loading device was oriented with its lateral axis at an angle of 25° below the horizontal. The forward-most edge of the loading device, along its longitudinal centerline, was located 10 inches forward of the forward-most portion of the roof, including windshield moulding.

A downward force was applied perpendicular to the test device's lower surface at a rate of not more than one half inch per second until reaching the required displacement or the maximum load limit.

The test vehicle was mounted on four (4) bedplate stands that were affixed to the bedplate with pinch bars. The stands were welded to the vehicle at the four manufacturer designated jacking points. (See photographs in Appendix A.)

The data channels were digitally sampled at twenty-five samples per second. The loading device was instrumented with two (2) force load cells and two (2) displacement potentiometers on the loading device cylinders. To collect additional data on the movement of the vehicle during the crush event, five (5) additional string potentiometers were recorded: four (4) potentiometers mounted to the bed plate and connected at the four corners of the vehicle behind

the bumper fascia and one (1) potentiometer mounted on an offboard stand and connected to the side sill opposite the loading side.

The test is summarized in Section 2.0. Appendix A contains the still photographic prints. Appendix B contains the data plots. Appendix C contains instrument calibration information.

Section 2.0

Roof Crush Resistance Test Summary

Test Results Summary

This roof crush resistance test was conducted at TRC Inc. on September 15, 2003.

The test vehicle, a 2001 Ford Taurus, was subjected to 254 millimeters (10.0 inches) of crush by the loading device on the left front roof edge.

The test vehicle sustained a peak load of 43000 Newtons at 186.5 millimeters of test device displacement. The test was completed in approximately 36.48 seconds.

Test set-up parameters are summarized in Table 2. Peak force or displacement data from each of the loading device and vehicle motion transducers is presented in Table 3. All plotted and tabular data is presented in SAE J211 Mar 95 sign convention.

Data Acquisition Explanations

There were no anomalies to report for this test.

Table 1 Test Vehicle Information

Vehicle year/make/ model/body style:	2001/Ford/Taurus/4-Door Sedan		
Color:	Beige		
VIN:	1FAFP52UX1G132085		
Unloaded Vehicle Weight:	N/A		
Engine data:			
Placement:	Transverse		
Type:	V		
Cylinders:	6		
Displacement:	3.0-liters		
Transmission data:	<u> 3 </u> speed,	<u> </u> manual,	<u> X </u> automatic, <u> X </u> overdrive
Final drive:	<u> X </u> fwd,	<u> </u> rwd,	<u> </u> 4wd
Date vehicle received:	09/11/03		
Odometer reading:	49263		
Dealer's name and address:	N/A (supplied by VRTC)		

Accessories:

Power steering	Yes	Automatic transmission	Yes
Power brakes	Yes	Automatic speed control	No
Power seats	No	Tilting steering wheel	Yes
Power windows	Yes	Telescoping steering wheel	No
Tinted glass	Yes	Air conditioning	Yes
Radio	Yes	Anti-skid brake	No
Clock	Yes	Rear window defroster	Yes
Power door locks	Yes	Other:	N/A

Table 1 Test Vehicle Information, Cont'd.

Certification data from vehicle's label:

Vehicle manufactured by: Ford Motor Company, Inc
Date of manufacture: 10/00
VIN: 1FAFP52UX1G132085
GVWR: 2124 kg (4684 lbs.)
GAWR: Front: 1168 kg (2577 lbs.)
Rear: 967 kg (2132 lbs.)

Tire Data:¹

Manufacturer and line of tires: Continental / Touring
Size of tires on vehicle: P205/70R15
Spare tire: Goodyear / Convenience Spare

Type of front seats: Bucket

Tire & capacity data from vehicle's label:

Recommended tire size: P215/60TR16
Recommended cold tire pressure:
Front: 207 kPa (30 psi)
Rear: 207 kPa (30 psi)
Designated Seating Capacity:
Front 2
Middle N/A
Rear 3
Total 5
Vehicle Capacity Weight: 499 kg (1100 lbs)

¹ Tires removed for test.

Table 2 Roof Crush Pre-Test Preparation and Test Parameters

Vehicle Year/Make/ Model/Body Style:	2001/Ford/Taurus/4-Door
Test Date:	September 15, 2003
Test Laboratory:	Transportation Research Center Inc.
Side of roof to be tested:	Left
Vehicle sill angle:	0.7 degrees nose up
Load plate pitch angle:	5 degrees
Load plate roll angle:	25 degrees
Targeted peak crush:	254 mm (10 inches)
Cylinder displacement rate:	7 mm/s

Figure 1 Vehicle Transducer Placement

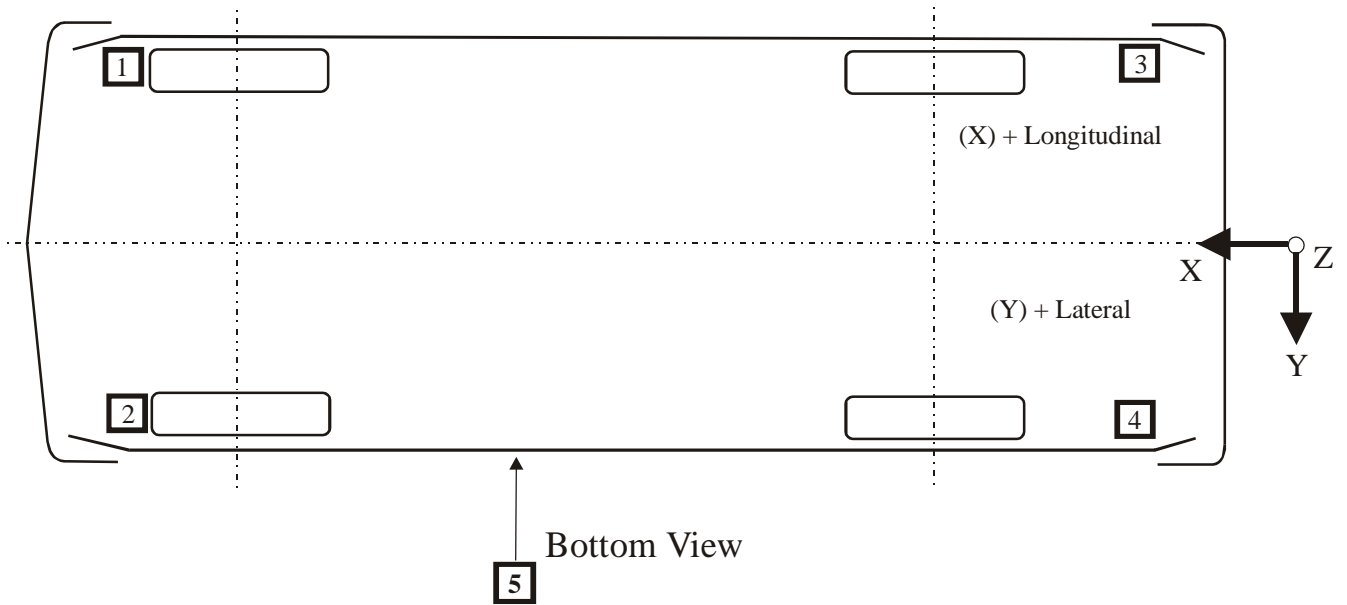
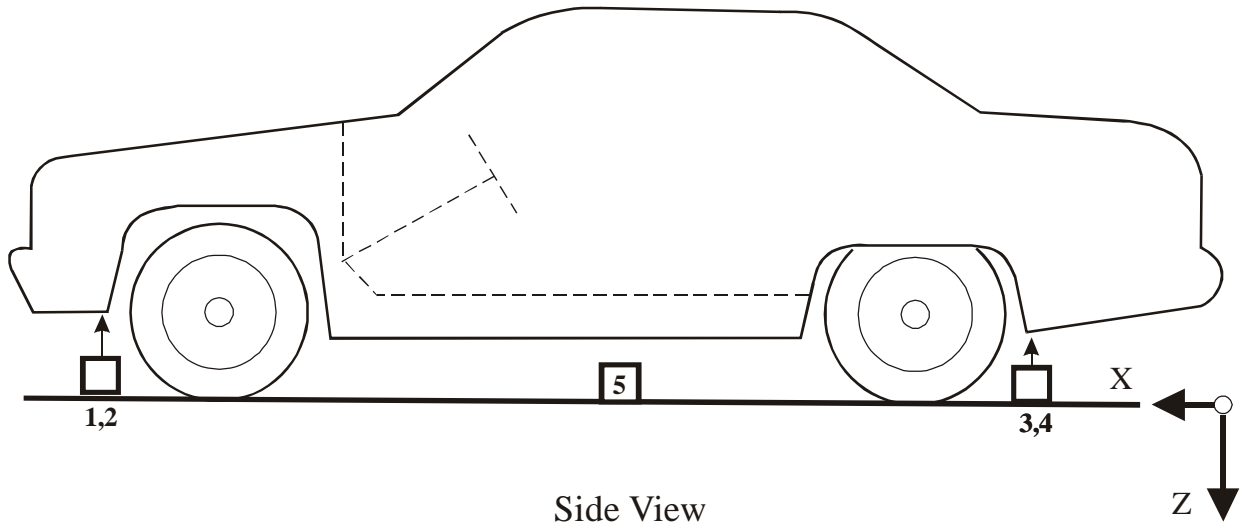


Table 3 Test Results

Vehicle Year/Make/
 Model/Body Style: 2001/Ford/Taurus/4-Door
 Test Date: September 15, 2003
 Test Laboratory: Transportation Research Center Inc.

Figure Number	Description	Maximum Value	Time of Maximum
	Load Cell 1 Force	10026.7 N	24.84 s
	Load Cell 2 Force	38075.5 N	36.48 s
	Total Load Cell Force	43000.0 N	27.00 s
	Cylinder 1 Displacement	252.1 mm	36.48 s
	Cylinder 2 Displacement	252.9 mm	36.48 s
	Average Cylinder Displacement	252.5 mm	36.48 s
1	Left Front Vehicle Vertical Displacement	3.3 mm	13.00 s
2	Right Front Vehicle Vertical Displacement	-3.7 mm	32.48 s
3	Left Rear Vehicle Vertical Displacement	20.6 mm	30.96 s
4	Right Rear Vehicle Vertical Displacement	15.2 mm	31.96 s
5	Opposite Side Vehicle Lateral Displacement	0.3 mm	17.80 s

Description	Maximum Force	Displacement at Time of Maximum Force
Total Force vs. Displacement	43000 N	186.5 mm

Appendix A

Photographs



Figure A-1 Pre Test Front - View 1



Figure A-2 Pre Test Front - View 2



Figure A-3 Pre-Test Left Front Angle View



Figure A-4 Pre-Test Left Side View



Figure A-5 Pre-Test Left Rear Angle View



Figure A-6 Pre-Test Rear View



Figure A-7 Pre-Test Right Side View



Figure A-8 Pre-Test Dummy Front View



Figure A-9 Pre-Test Dummy Left Front Angle View

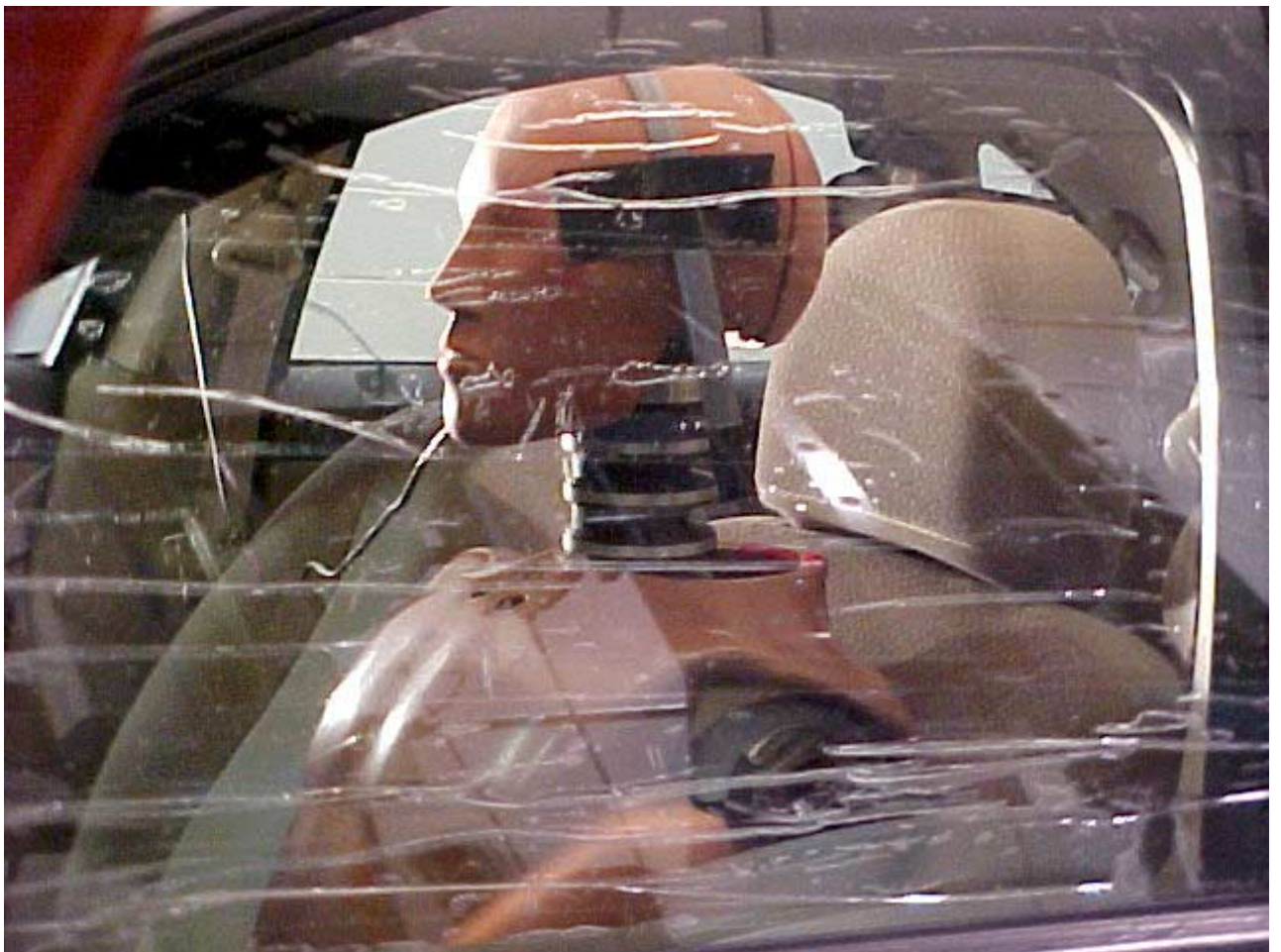


Figure A-10 Pre-Test Dummy Left Side View



Figure A-11 Pre-Test Dummy Right Side View



Figure A-12 Pre-Test Loading Device Initial Contact Point View

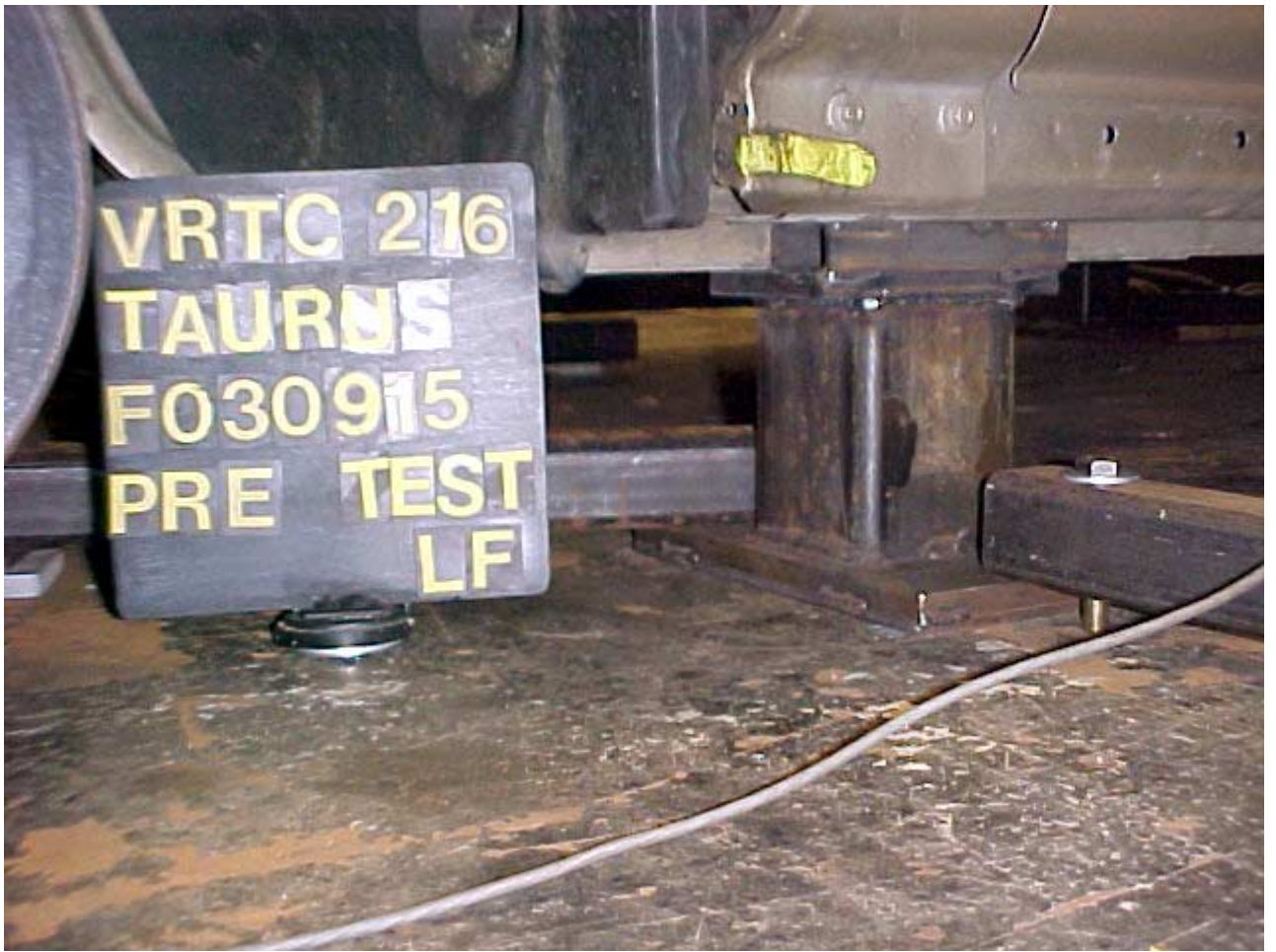


Figure A-13 Pre-Test Left Front Stand and Reinforcement View

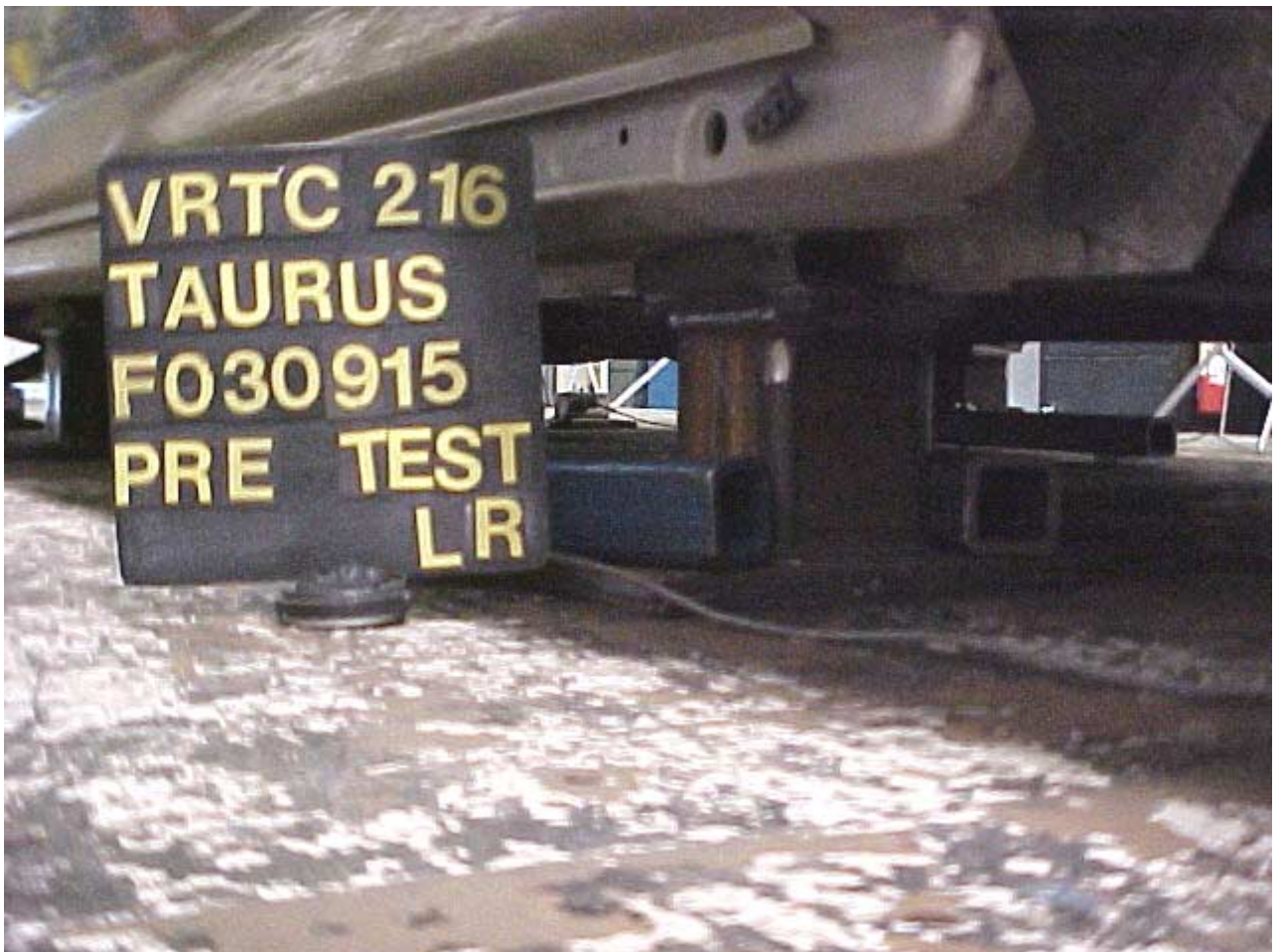


Figure A-14 Pre-Test Left Rear Stand and Reinforcement View

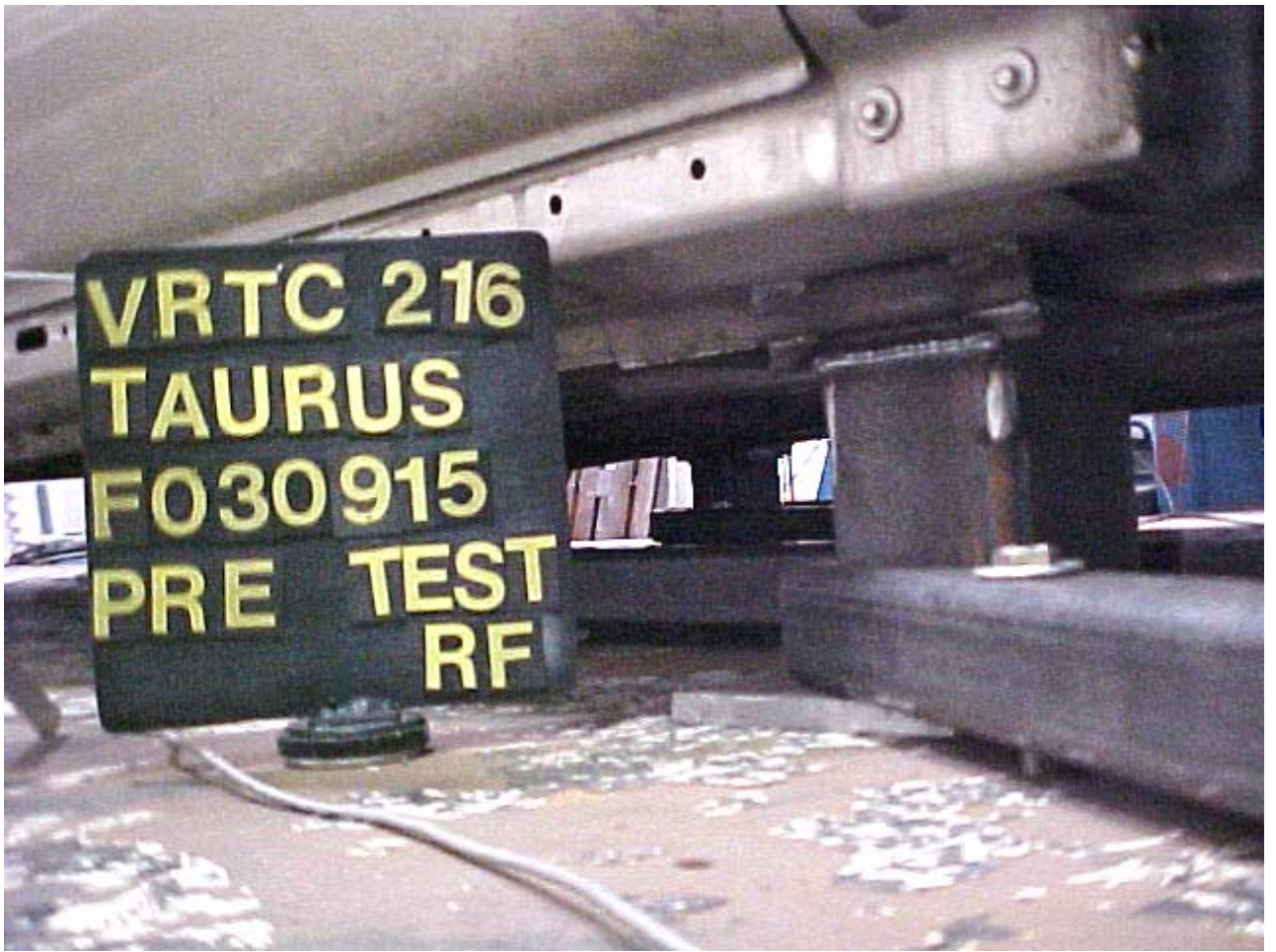


Figure A-15 Pre-Test Right Front Stand and Reinforcement View



Figure A-16 Pre-Test Right Rear Stand and Reinforcement View

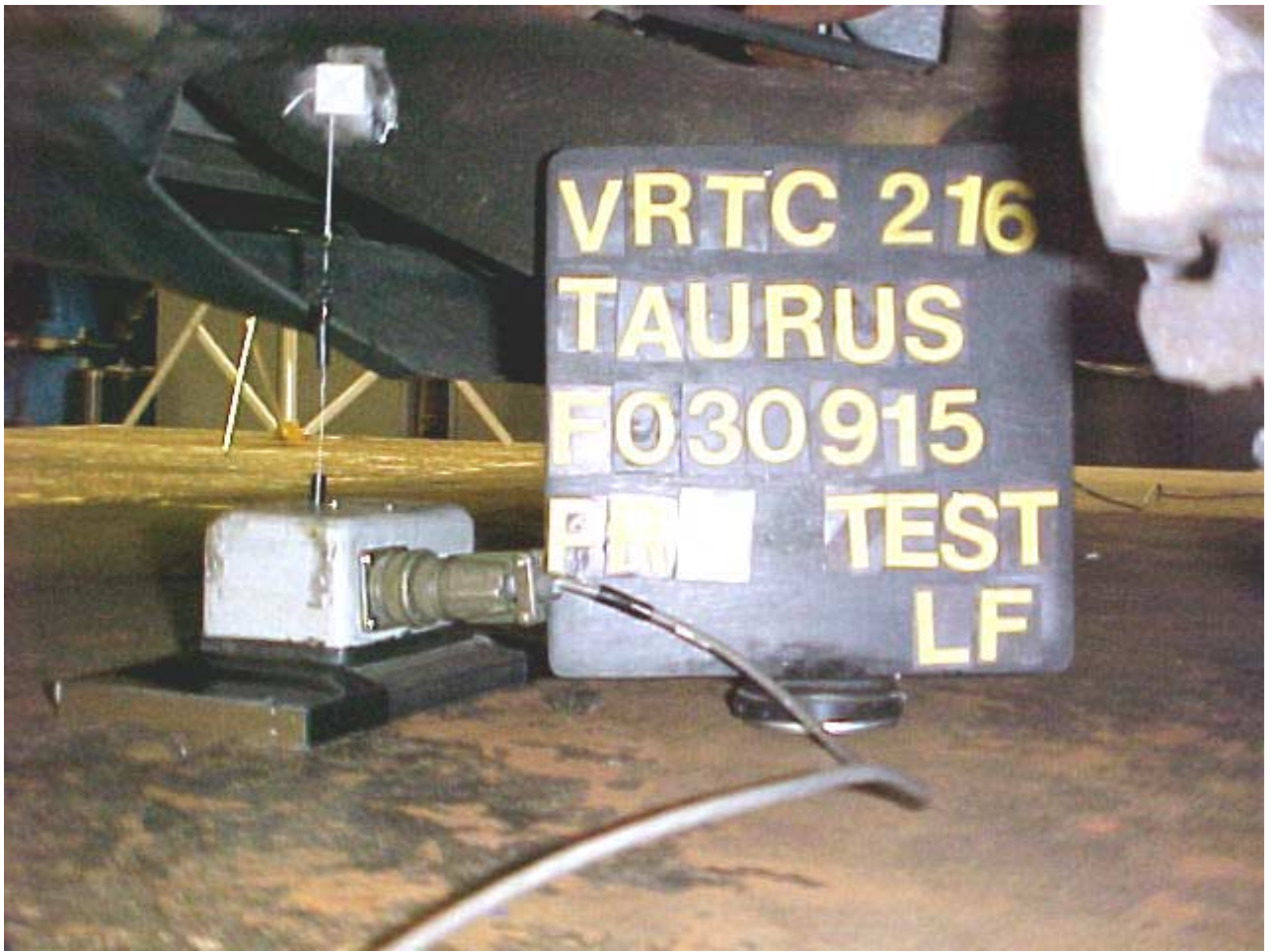


Figure A-17 Pre-Test Left Front Displacement Potentiometer View



Figure A-18 Pre-Test Left Rear Displacement Potentiometer View



Figure A-19 Pre-Test Right Front Displacement Potentiometer View



Figure A-20 Pre-Test Right Rear Displacement Potentiometer View



Figure A-21 Pre-Test Opposite Side Lateral Displacement Potentiometer View



Figure A-22 Pre-Test Interior Roof View



Figure A-23 Post-Test Maximum Stroke Front View



Figure A-24 Post-Test Front - View 1



Figure A-25 Post-Test Front - View 2



Figure A-26 Post-Test Left Front Angle View



Figure A-27 Post-Test Left Side View



Figure A-28 Post-Test Left Rear Angle View



Figure A-29 Post-Test Rear View



Figure A-30 Post-Test Right Side View



Figure A-31 Post-Test Dummy Front View



Figure A-32 Post-Test Dummy Left Side View

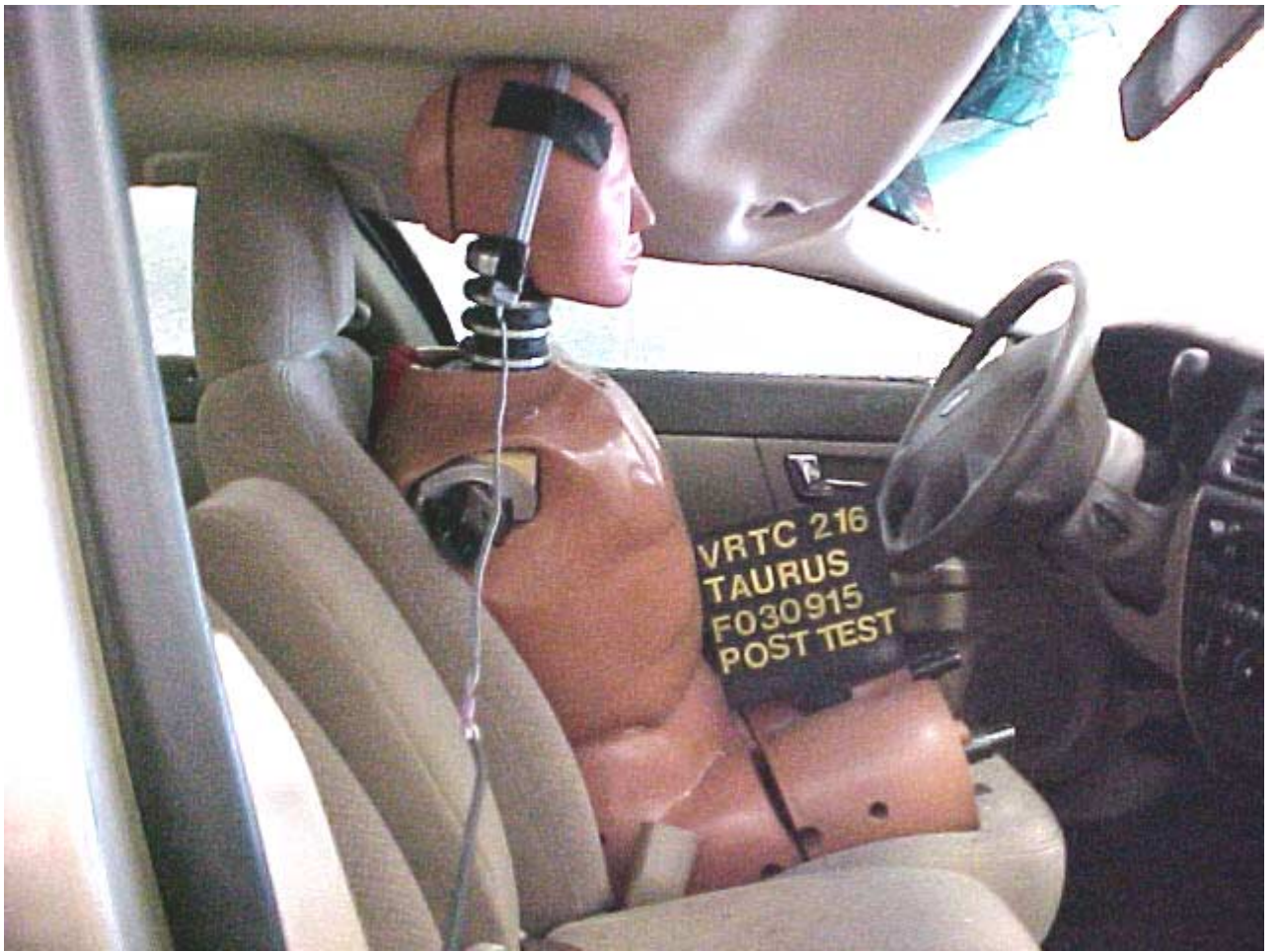


Figure A-33 Post-Test Dummy Right Side – View 1



Figure A-34 Post-Test Dummy Right Side – View 2



Figure A-35 Post-Test Vehicle Damage - View 1



Figure A-36 Post-Test Vehicle Damage - View 2



Figure A-37 Post-Test Vehicle Damage - View 3



Figure A-38 Post-Test Vehicle Damage - View 4



Figure A-39 Post-Test Vehicle Damage - View 5



Figure A-40 Post-Test Vehicle Damage - View 6



Figure A-41 Post-Test Left Front Stand and Reinforcement View



Figure A-42 Post-Test Left Rear Stand and Reinforcement View



Figure A-43 Post-Test Right Front Stand and Reinforcement View



Figure A-44 Post-Test Right Rear Stand and Reinforcement View



Figure A-45 Post-Test Interior Roof – View 1



Figure A-46 Post-Test Interior Roof – View 2

MFD. BY FORD MOTOR CO. IN U.S.A.

DATE: 10/00 GVWR: 2124KG/4684LB
 FRONT GAWR: 1168KG/2577LB REAR GAWR: 967KG/2132LB

THIS VEHICLE CONFORMS TO ALL APPLICABLE FEDERAL MOTOR
 VEHICLE SAFETY, BUMPER, AND THEFT PREVENTION STANDARDS
 IN EFFECT ON THE DATE OF MANUFACTURE SHOWN ABOVE.

VIN: 1FAPP52UX1G132085 TYPE: PASSENGER
 MAXIMUM LOAD = OCCUPANTS + LUGGAGE = 499KG/1100LB
 OCCUPANTS = 5/6 TOTAL: 2/3 FR, 3 RR
 LUGGAGE = 091KG/0200LB
 TIRE: P215/60TR16
 PRESSURE(FR): 207 kPa/ 30 PSI COLD
 PRESSURE(RR): 207 kPa/ 30 PSI COLD



1FAPP52UX1G132085

TRAILER TOWING - SEE OWNER GUIDE

EXT PNT: R7		LRC: 47		LDS:		F0183 R0153	
BRK	INT TR	TP/PS	R	AXLE	TR		SPR
A	GH		F	3R	L	BBCC	S05
							UBC ♡FBDB-5420472-AB

Figure A-47 Vehicle Certification / Tire Information Label

Appendix B

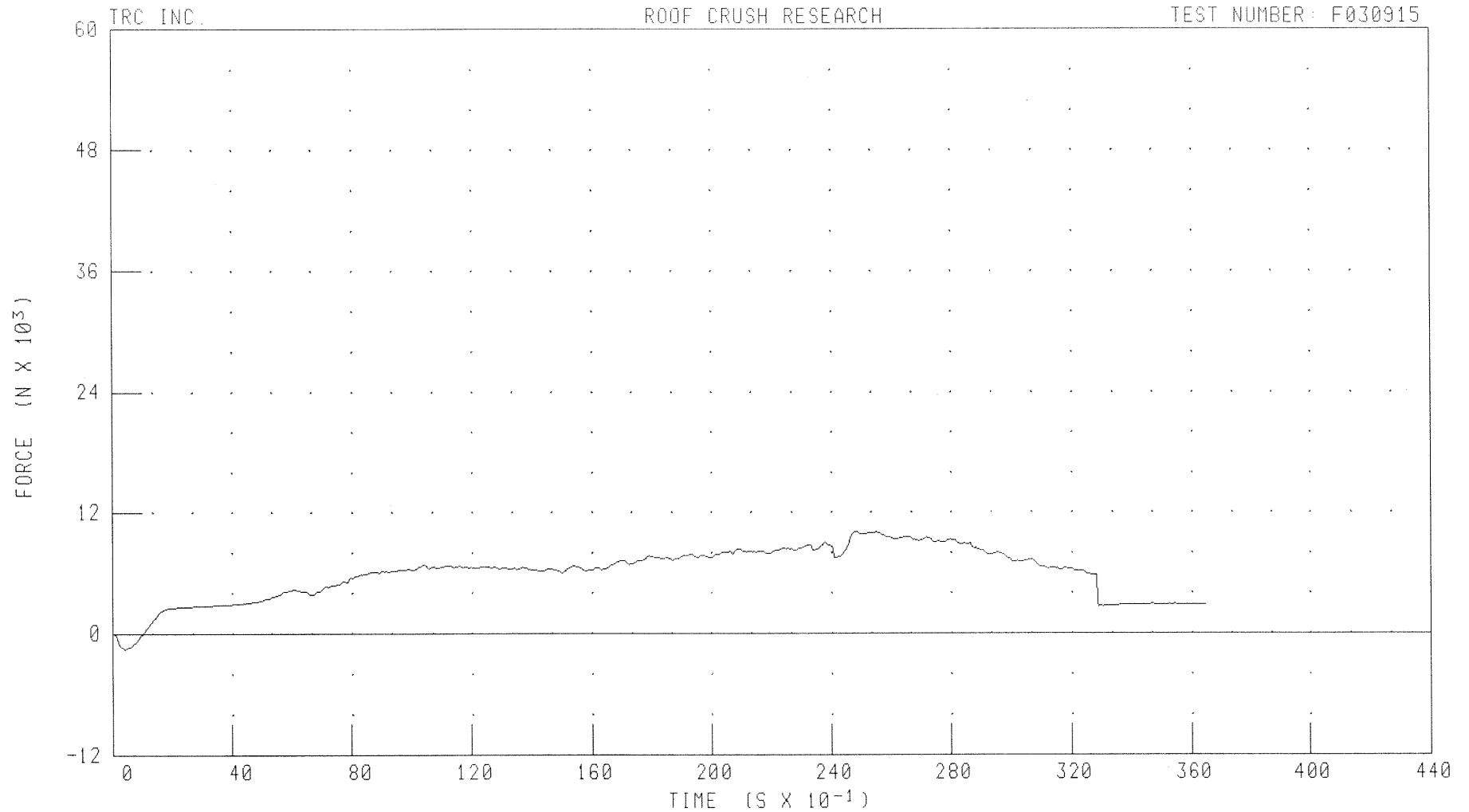
Data Plots

2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL

LOAD CELL 1 FORCE

ROOF CRUSH RESEARCH

TEST NUMBER: F030915



CHANNEL: LC1

FILTER: CH. CLASS 1000

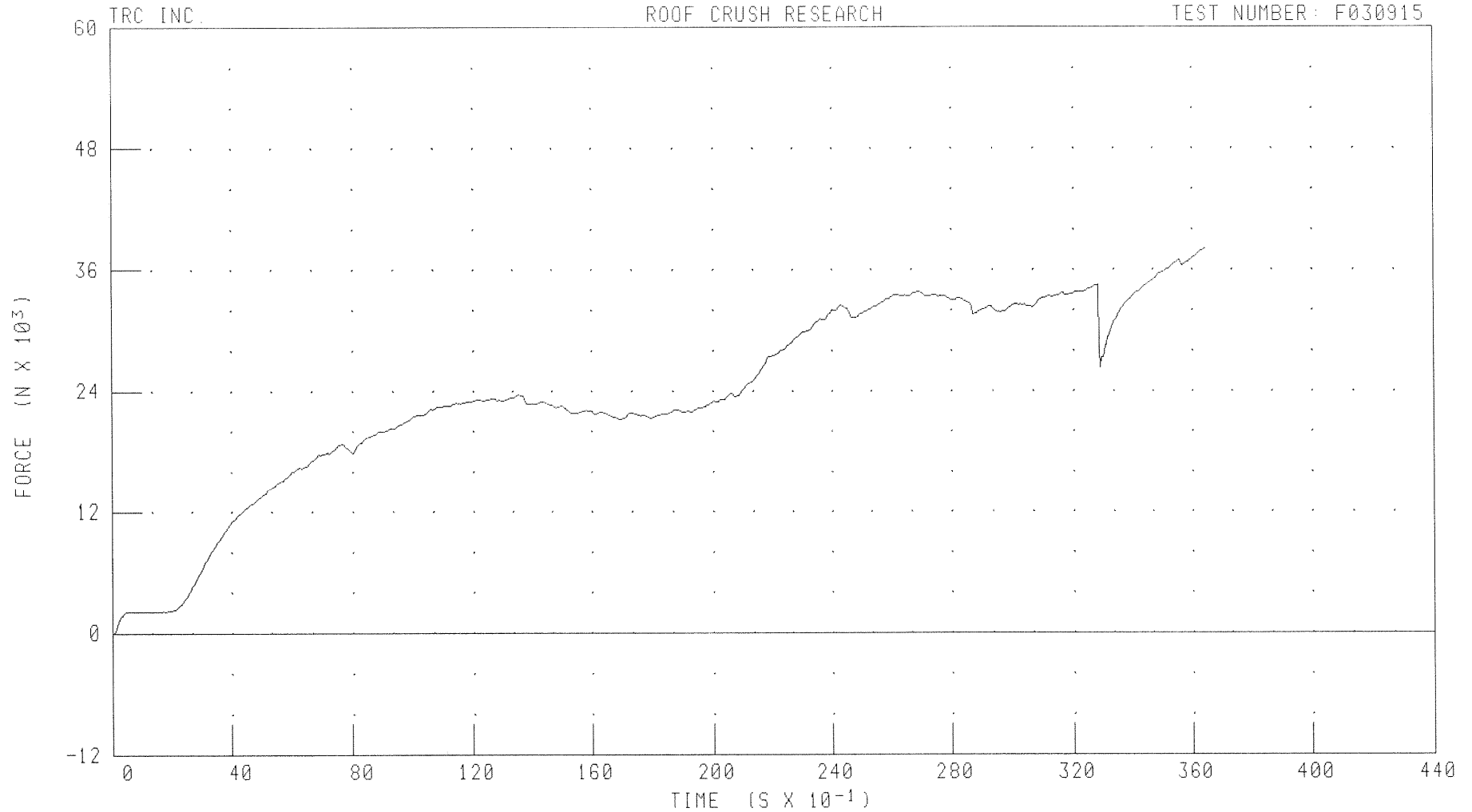
PEAK DATA: 10026.66 N @ 24.84 S; -1507.67 N @ 0.44 S

2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL

LOAD CELL 2 FORCE

ROOF CRUSH RESEARCH

TEST NUMBER: F030915



CHANNEL: LC2

FILTER: CH. CLASS 1000

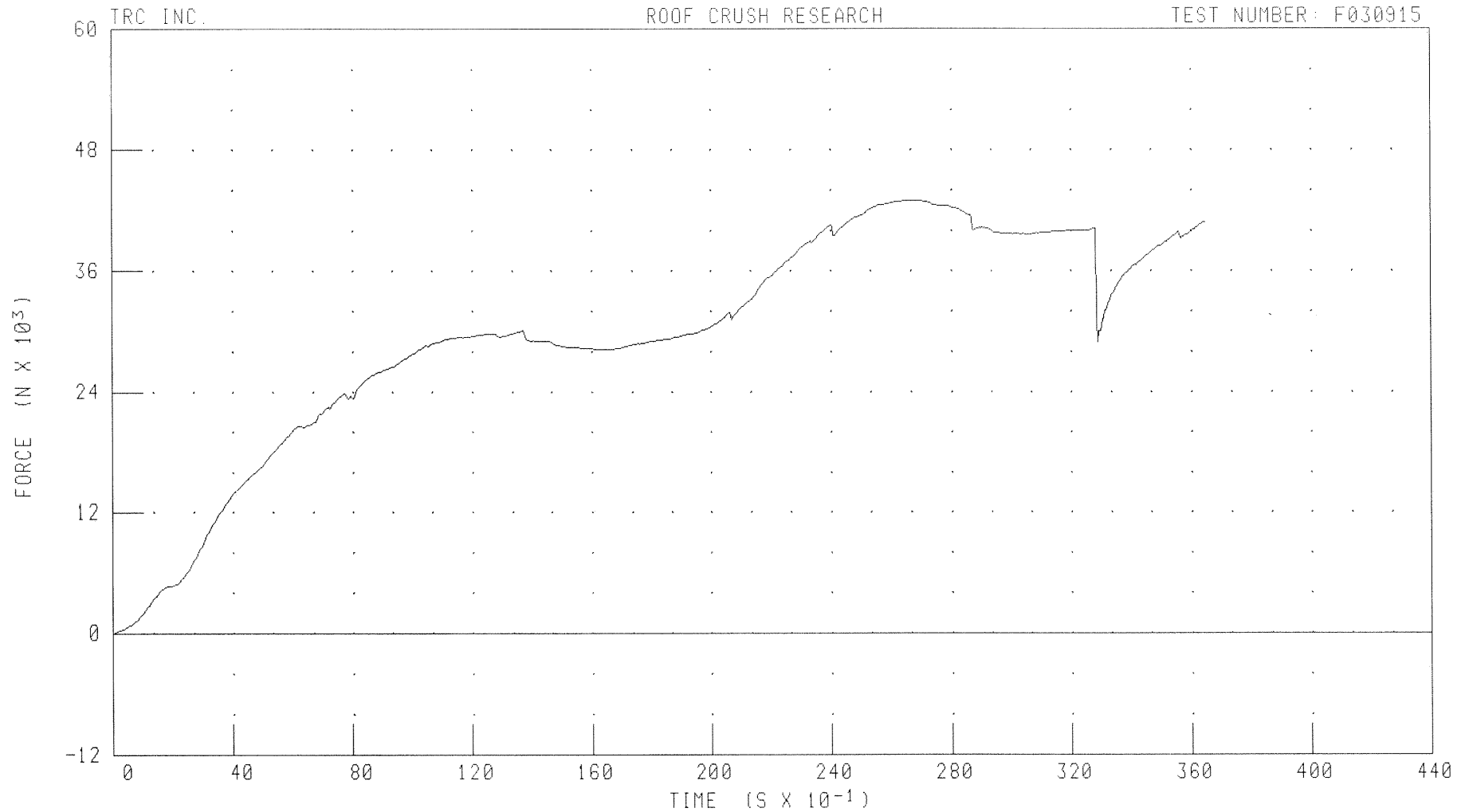
PEAK DATA: 38075.46 N @ 36.48 S; 9.53 N @ 0.00 S

2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL

TOTAL LOAD CELL FORCE

ROOF CRUSH RESEARCH

TEST NUMBER: F030915



CHANNEL: TOT

FILTER: CH. CLASS 1000

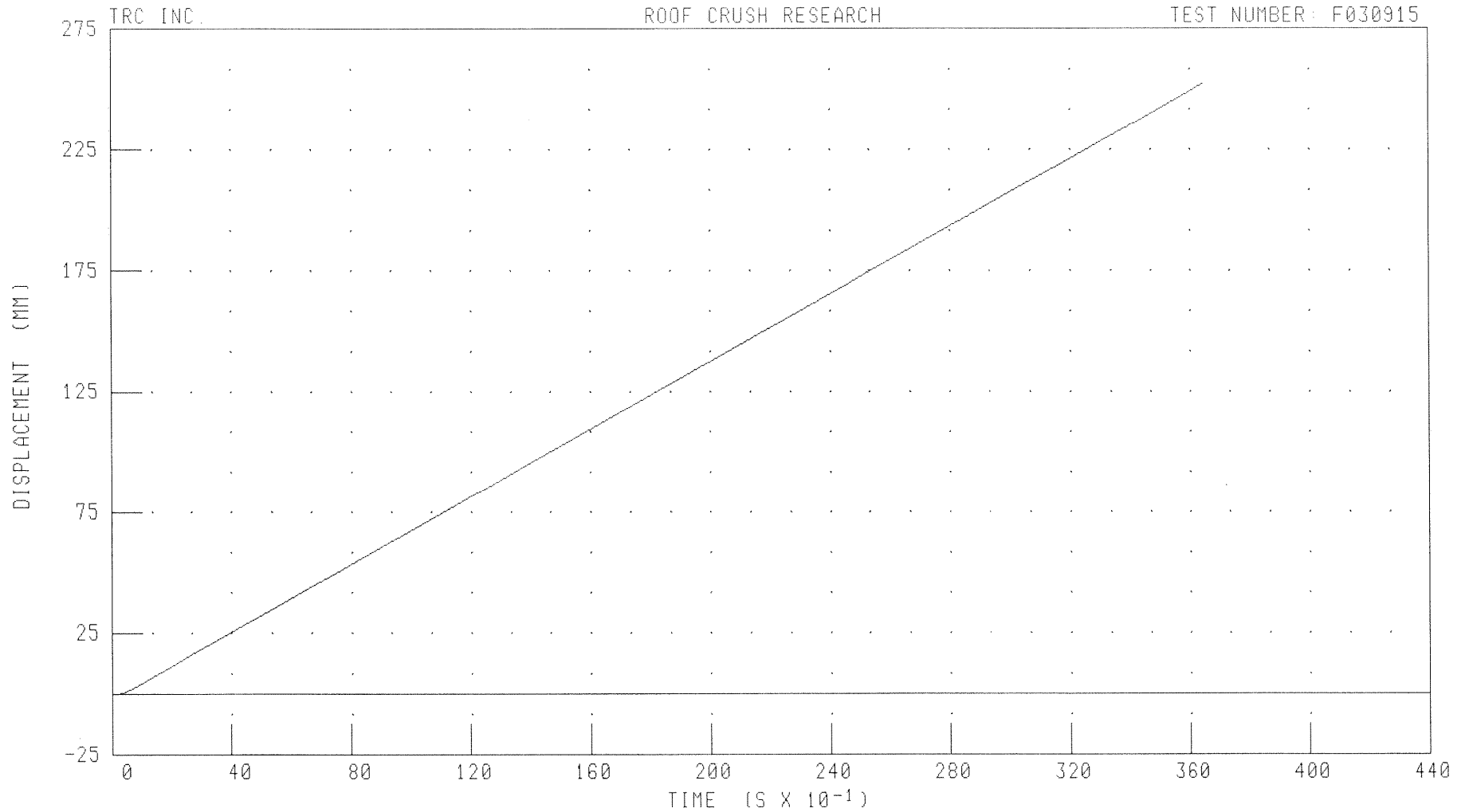
PEAK DATA: 42999.97 N @ 27.00 S; -19.25 N @ 0.04 S

2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL

CYLINDER 1 DISPLACEMENT

ROOF CRUSH RESEARCH

TEST NUMBER: F030915



CHANNEL: DISP1 FILTER: CH. CLASS 1000

PEAK DATA: 252.11 MM @ 36.48 S; -0.08 MM @ 0.08 S

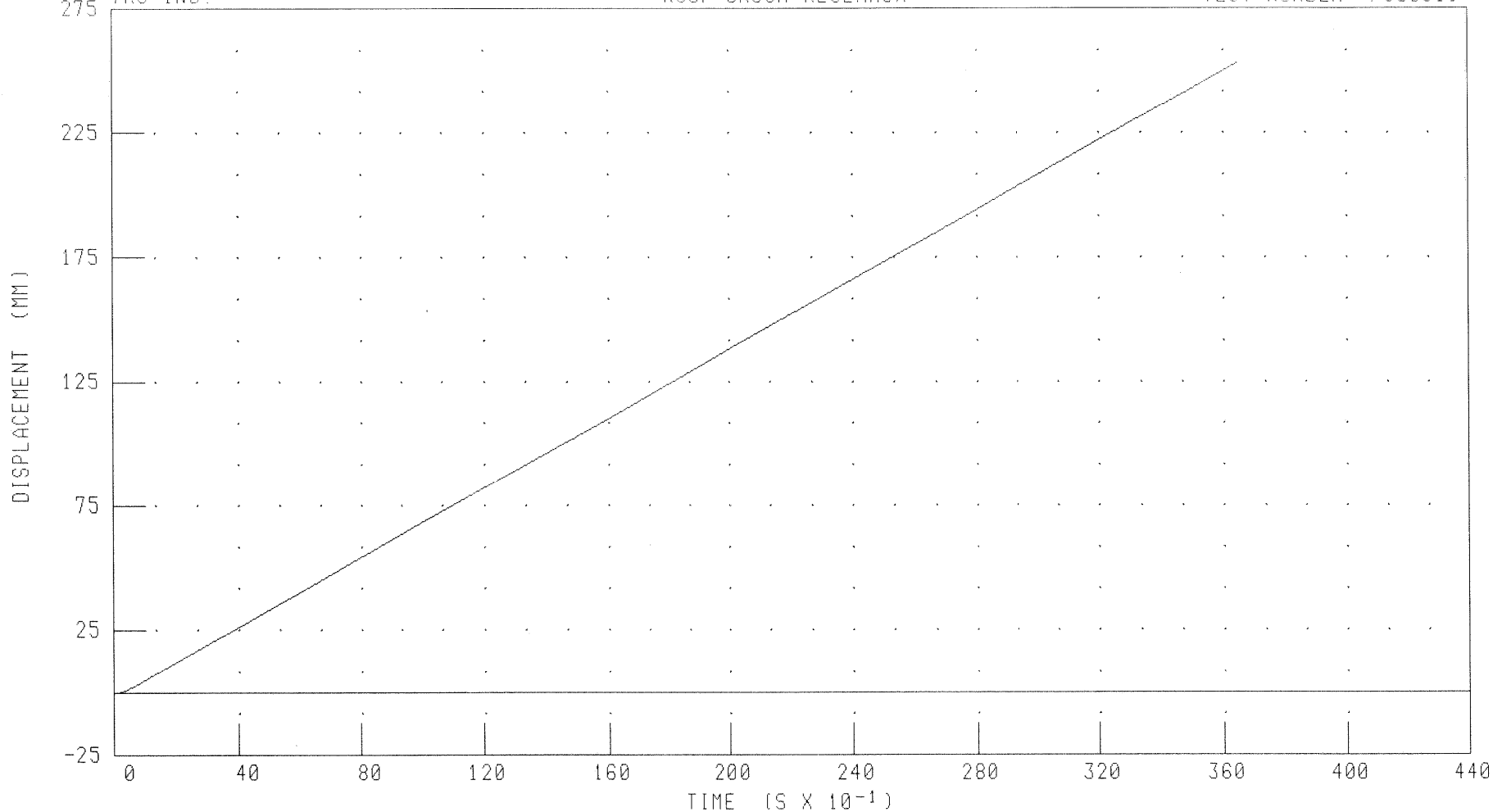
2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL

CYLINDER 2 DISPLACEMENT

ROOF CRUSH RESEARCH

TEST NUMBER: F030915

TRC INC.



CHANNEL: DISP2

FILTER: CH. CLASS 1000

PEAK DATA: 252.88 MM @ 36.48 S, -0.02 MM @ 0.00 S

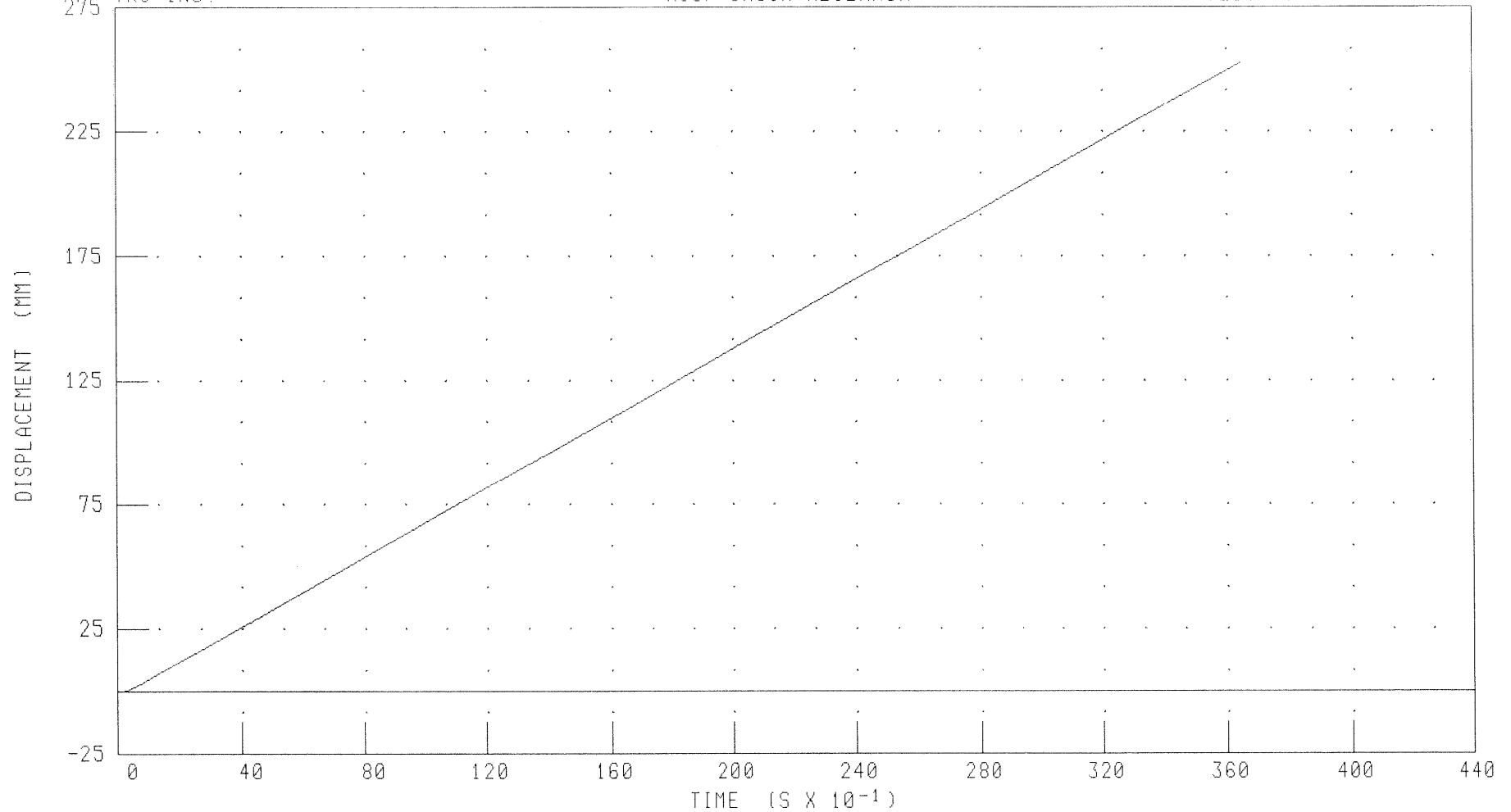
2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL

AVERAGE CYLINDER DISPLACEMENT

TRC INC.

ROOF CRUSH RESEARCH

TEST NUMBER: F030915



CHANNEL: AVG

FILTER: CH. CLASS 1000

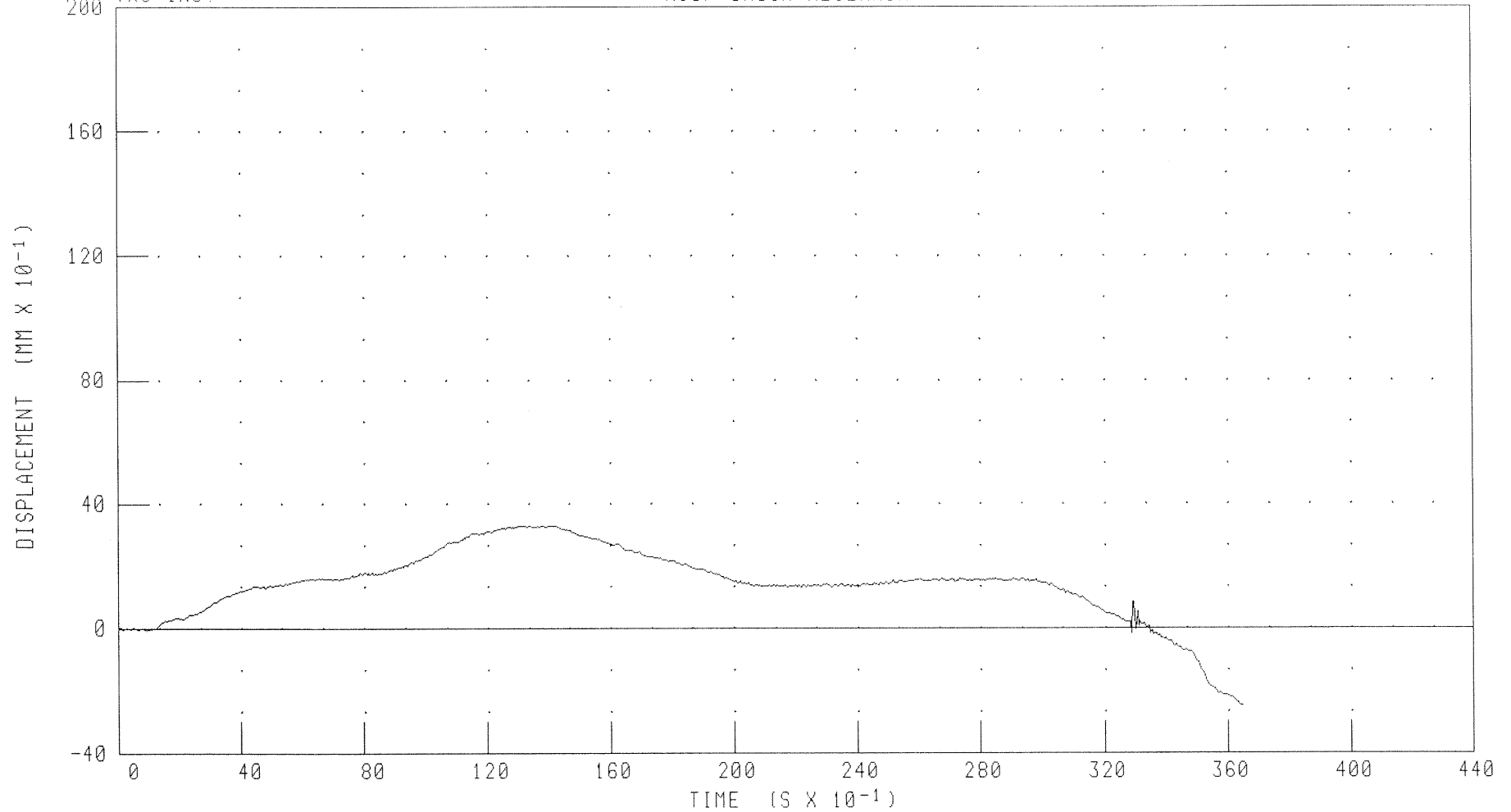
PEAK DATA: 252.50 MM @ 36.48 S; -0.01 MM @ 0.04 S

2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL
LEFT FRONT VEHICLE VERTICAL DISPLACEMENT

TRC INC.

ROOF CRUSH RESEARCH

TEST NUMBER: F030915



CHANNEL: BMLFZD FILTER: CH. CLASS 1000

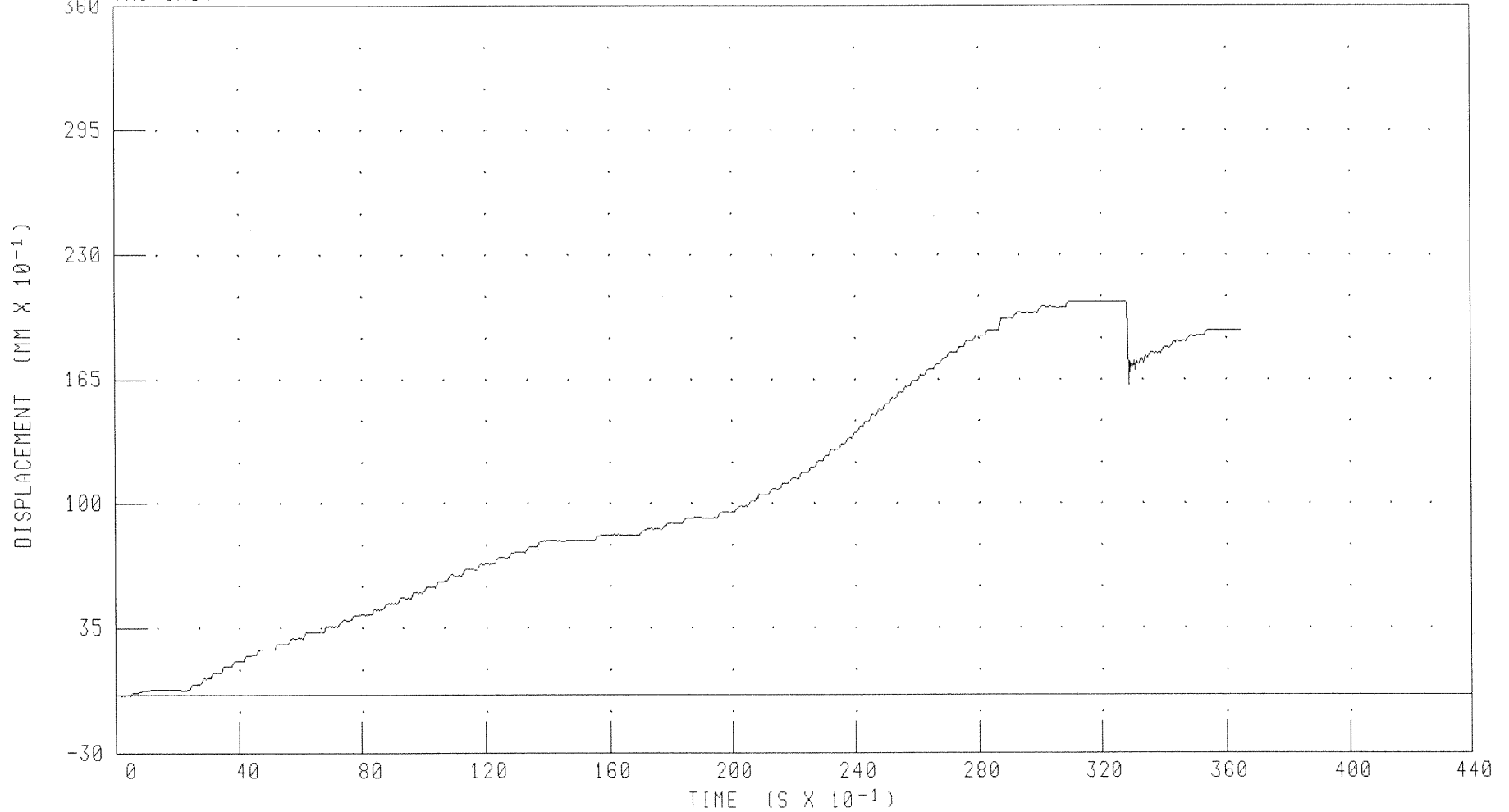
PEAK DATA: 3.27 MM @ 13.00 S; -2.47 MM @ 36.40 S

2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL
LEFT REAR VEHICLE VERTICAL DISPLACEMENT

TRC INC.

ROOF CRUSH RESEARCH

TEST NUMBER: F030915



CHANNEL: BMLRZD FILTER: CH. CLASS 1000

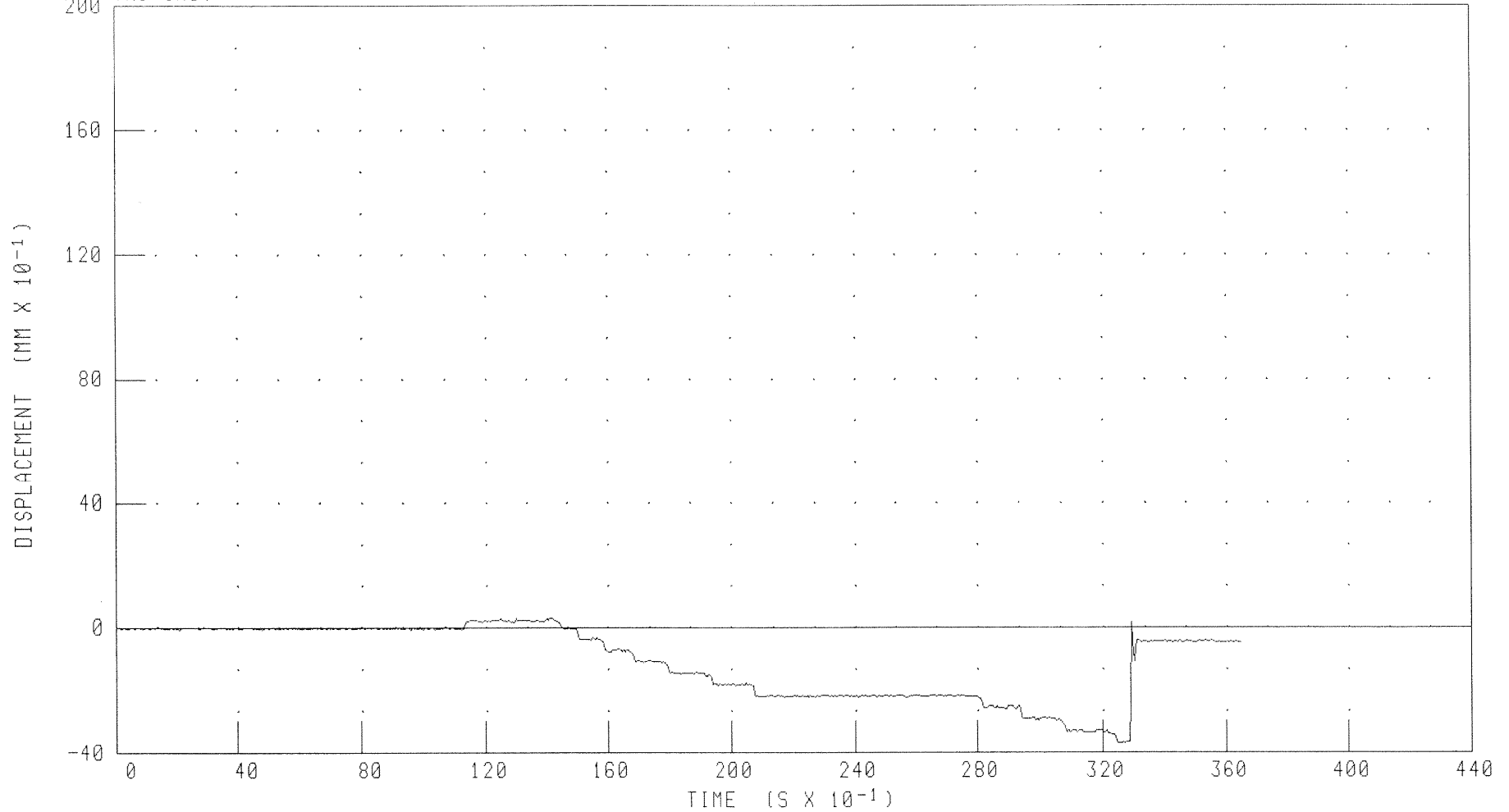
PEAK DATA: 20.57 MM @ 30.96 S; -0.03 MM @ 0.16 S

2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL
RIGHT FRONT VEHICLE VERTICAL DISPLACEMENT

TRC INC.

ROOF CRUSH RESEARCH

TEST NUMBER: F030915



CHANNEL: BMRFZD FILTER: CH. CLASS 1000

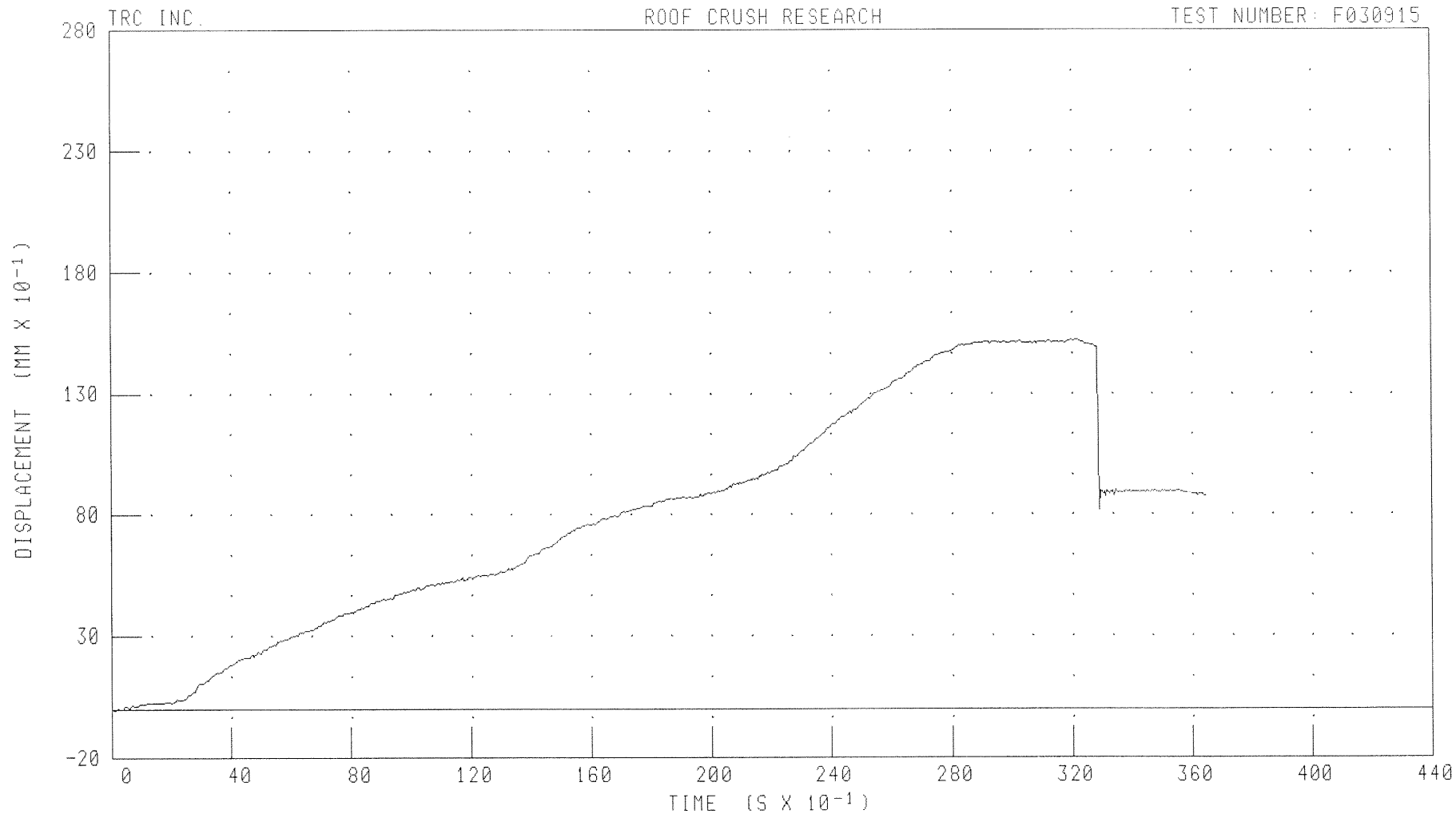
PEAK DATA: 0.29 MM @ 12.48 S; -3.71 MM @ 32.48 S

2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL
RIGHT REAR VEHICLE VERTICAL DISPLACEMENT

TRC INC.

ROOF CRUSH RESEARCH

TEST NUMBER: F030915



CHANNEL: BMRRZD FILTER: CH. CLASS 1000

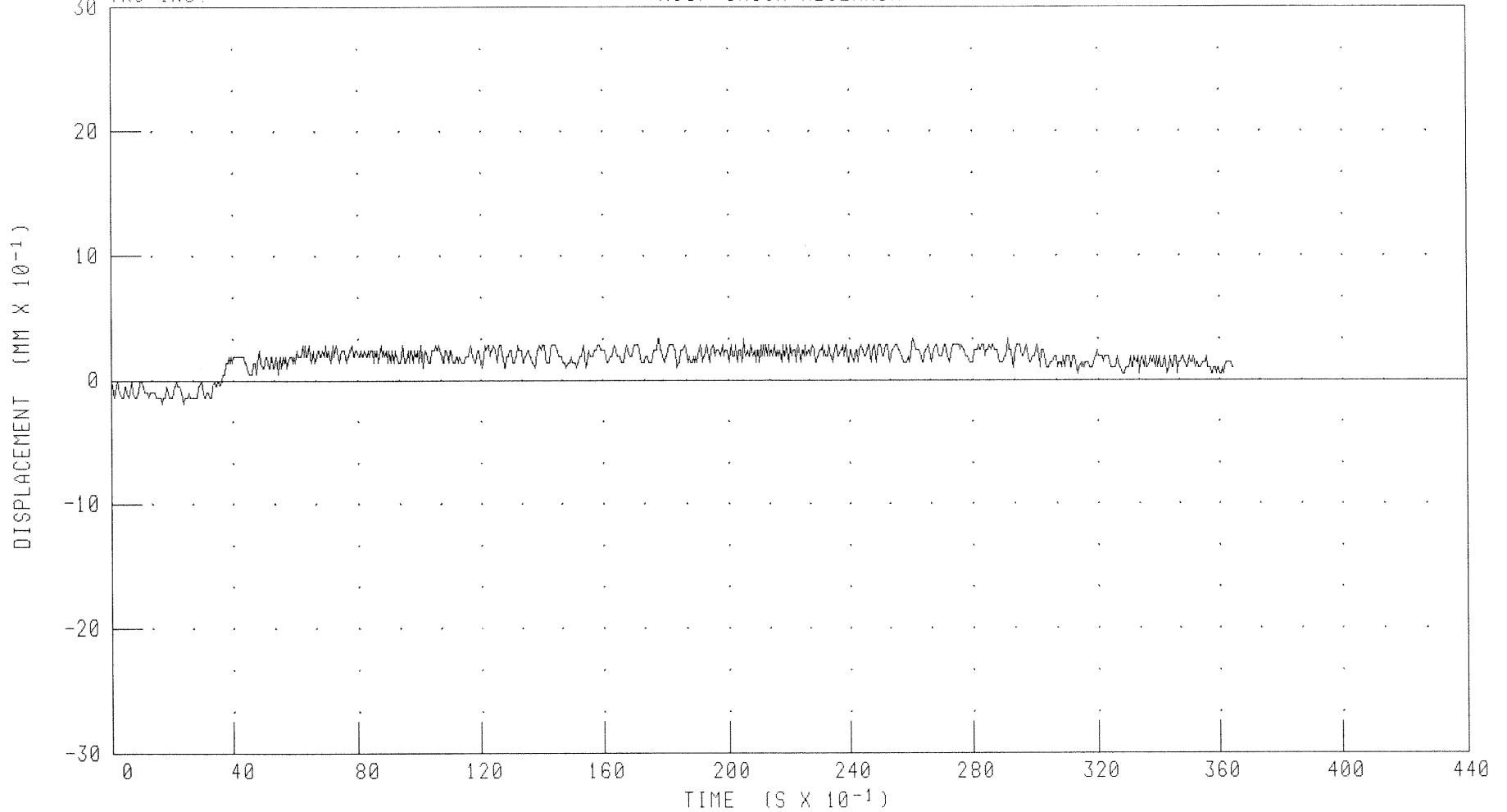
PEAK DATA: 15.24 MM @ 31.96 S; -0.05 MM @ 0.08 S

2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL
OPPOSITE SIDE SILL LATERAL DISPLACEMENT

TRC INC.

ROOF CRUSH RESEARCH

TEST NUMBER: F030915



CHANNEL: DSRFYD FILTER: CH. CLASS 1000

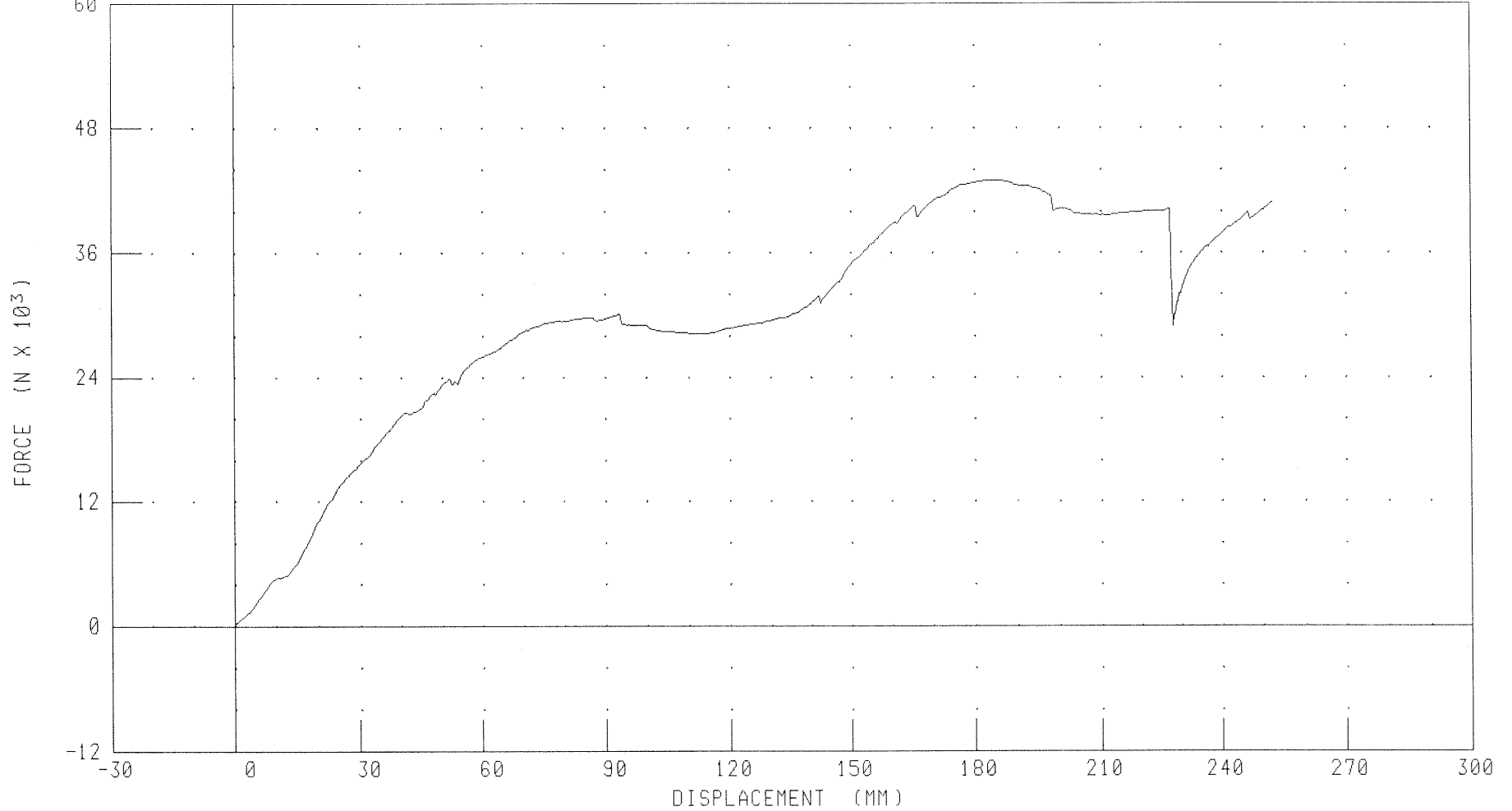
PEAK DATA: 0.33 MM @ 17.80 S; -0.19 MM @ 1.68 S

2001 FORD TAURUS - ROOF CRUSH AT 5 DEGREE PITCH / 25 DEGREE ROLL
TOTAL FORCE VS AVERAGE CYLINDER DISPLACEMENT

TRC INC.

ROOF CRUSH RESEARCH

TEST NUMBER: F030915



CHANNEL: AVG
TOT

FILTER: CH. CLASS 1000
CH. CLASS 1000

PEAK DATA: 252.50 MM @ 36.48 S; -0.01 MM @ 0.04 S
42999.97 N @ 27.00 S; -19.25 N @ 0.04 S

Appendix C

Test Instrument Calibration Information

Test Instrument Calibration Information

Instrument Location	Instrument Type	Serial Number	Model Number	Mfr.	Calibration Date
Loading Device Cylinder 1	Load cell	253	1202-05	Key	03/11/03
Loading Device Cylinder 2	Load cell	254	1202-05	Key	03/11/03
Loading Device Cylinder 1	Displacement	216 Left	TTSRBU0240AS2B	MTS	09/10/03
Loading Device Cylinder 2	Displacement	216 Right	TTSRBU0240AS2B	MTS	09/10/03
Left Front Vehicle	Displacement	A02465	PT-101-40	Celesco	07/11/03
Right Front Vehicle	Displacement	A51808	PT-101-0050	Celesco	07/17/03
Left Rear Vehicle	Displacement	0586135	PT-101-40B	Celesco	02/14/03
Right Rear Vehicle	Displacement	A23306	PT-101-0060	Celesco	07/11/03
Opposite Side Vehicle	Displacement	A23305	PT-101-0060	Celesco	07/23/03