

76 MAY 31
C.B. Winkler

UMTRI

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Report on Failure Testing of Thirty Tires

Introduction

UMTRI has completed an experimental program to determine the inflation pressure required to fail a sample of thirty individual 16 inch light truck tires when those tires are mounted on 16.5 inch wheels.

It is possible to improperly installed a 16 inch tire (metric 215/85, in this case) on a 16.5 inch tire wheel. When this is the case, the tire bead may make an air tight seal against the wheel, even though the bead is not properly seated. If inflation pressure is then elevated, the improper seating of the tire can generate excessive stresses in the bead wire, eventually resulting in failure of the wire and explosive deflation of the tire as the integrity of the bead seat is lost. Such a failure was obtained for each of thirty tires tested.

Test Sample

The tire sample consisted of six tires each, of the following:

- i) Michelin Radial XCH4 All Season LT215/85, Load range D, rib
- ii) Firestone, SteelTex Radial FSR, LT215/85, Load range D, rib
- iii) BF Goodrich, The Edge, LT215/85, Load range D, rib
- iv) Dunlop, A/P Radial Rover, LT215/85, Load range D, rib
- v) Goodyear, Wrangler LT, LT215/85, Load range D, rib

Test Procedure

Two special wheels, each equipped with two valve stem holes, were used for these tests. (These wheels were virtually identical. Two were used simply to facilitate an efficient use of time.) A length of high pressure hose was attached to each hole. One hose was used to connect the system to a compressed air source for inflating the tire; the other hose was used to feed electronic pressure transducers for measuring the inflation pressure of the tire. Physically separating these two functions served to insure that accuracy of inflation pressure measurements was not compromised by the dynamic effects of the flow of inflation air.

The individual test tires were mounted on these wheels, and, in turn, mounted on a structure suitable for safely constraining the tire and wheel at failure. The test tire was then slowly inflated (at approximately 1 to 3 psi per second). Starting at an inflation pressure of approximately 40 psi, a continuous recording of inflation pressure was made until failure of the tire was achieved.

Transportation
Research Institute

Results

Essentially, two "modes" of test progression were observed, viz.:

- 1) Inflation progressed "smoothly" over time, and no identifiable "events" occurred except for the explosive failure of the tire.
- 2) Inflation progressed smoothly up to an intermediate level at which a sharp "pop" occurred (apparently as the tire beads seated firmly against the wheel seat). The "pop" was accompanied quick reduction of inflation pressure of a few psi. Subsequently, inflation pressure again proceeded smoothly until failure occurred.

Appended to this report is plot of the time history of inflation pressure for all thirty trials. (The test log sheets for each trail are also appended.) The plots are organized by tire make. All trials of the "mode 1" type for and individual make are presented together on one plot. Each trial of a "mode 2" type has an individual plot accompanied by a "blow up" of the "pop" region of the data. Mode 2 type results occurred for only three of the six Goodyear tires and two of the six Dunlop tires.

Table 1 presents the failure pressure from each of the thirty trials. Table 2 presents statistical results derived from the data of Table 1. Figures 1 and 2 present the more interesting statistical results in graphical form.

Table 1. Tire Failure Pressures, psi					
Trial	Michelin	Firestone	Goodrich	Dunlop	Goodyear
1	88.6	77.8	98.4	118.8	164.3
2	79.8	76.8	106.3	91.8	179.9
3	79.3	83.8	138.0	104.3	178.8
4	79.7	76.9	111.0	89.3	226.1
5	80.7	80.5	119.7	181.0	237.2
6	92.3	103.6	116.7	159.9	229.9

Figure 1 compares the means and standard deviations of the failure pressures of the six trials of each tire make. The means of the six trials range from a low of 83 psi for the Michelin tires and the Firestone tires to a high of 203 psi for the Goodyear tires. The standard deviations of the six trails range from a low of 5.6 psi for the Michelin tires to a high of 37.9 psi for the Dunlop tires.

Figure 2 again presents the means of the failure pressures of the six trials of each tire make. It also shows the 95% and 99% confidence bands of those means.

Table 2. Failure Pressure Test Statistics

Michelin

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
83.388	5.577	2.277	31.103	6.688	6
Minimum:	Maximum:	Range:	Sum:	Sum Squared:	* Missing:
79.33	92.25	12.92	500.33	41877.199	0
t 95%:	95% Lower:	95% Upper:	t 99%:	99% Lower:	99% Upper:
5.854	77.535	89.242	9.18	74.208	92.569

Firestone

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
83.23	10.346	4.224	107.036	12.43	6
Minimum:	Maximum:	Range:	Sum:	Sum Squared:	* Missing:
76.77	103.64	26.87	499.38	42098.579	0
t 95%:	95% Lower:	95% Upper:	t 99%:	99% Lower:	99% Upper:
10.859	72.371	94.089	17.031	66.199	100.261

Goodrich

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
115.005	13.564	5.538	183.995	11.795	6
Minimum:	Maximum:	Range:	Sum:	Sum Squared:	* Missing:
98.35	137.95	39.6	690.03	80276.876	0
t 95%:	95% Lower:	95% Upper:	t 99%:	99% Lower:	99% Upper:
14.237	100.768	129.242	22.329	92.676	137.334

Dunlop

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
124.19	37.947	15.492	1439.959	30.555	6
Minimum:	Maximum:	Range:	Sum:	Sum Squared:	* Missing:
89.29	181.02	91.73	745.14	99738.731	0
t 95%:	95% Lower:	95% Upper:	t 99%:	99% Lower:	99% Upper:
39.828	84.362	164.018	62.465	61.725	186.655

Goodyear

Mean:	Std. Dev.:	Std. Error:	Variance:	Coef. Var.:	Count:
202.685	31.761	12.966	1008.739	15.67	6
Minimum:	Maximum:	Range:	Sum:	Sum Squared:	* Missing:
164.25	237.19	72.94	1216.11	251530.951	0
t 95%:	95% Lower:	95% Upper:	t 99%:	99% Lower:	99% Upper:
33.336	169.349	236.021	52.282	150.403	254.967

Figure 1. Failure Pressures by Tire Make
—The Mean Values and Standard Deviations
from Six Trials of Each Make—

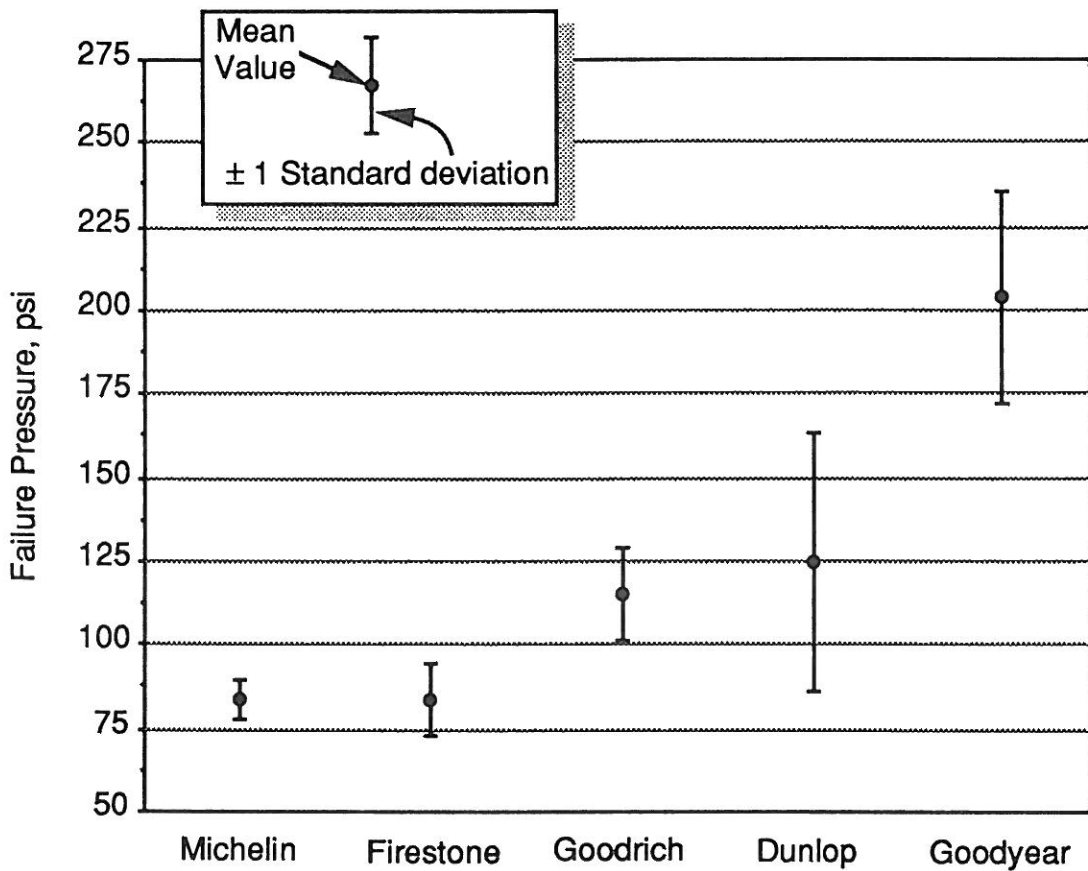
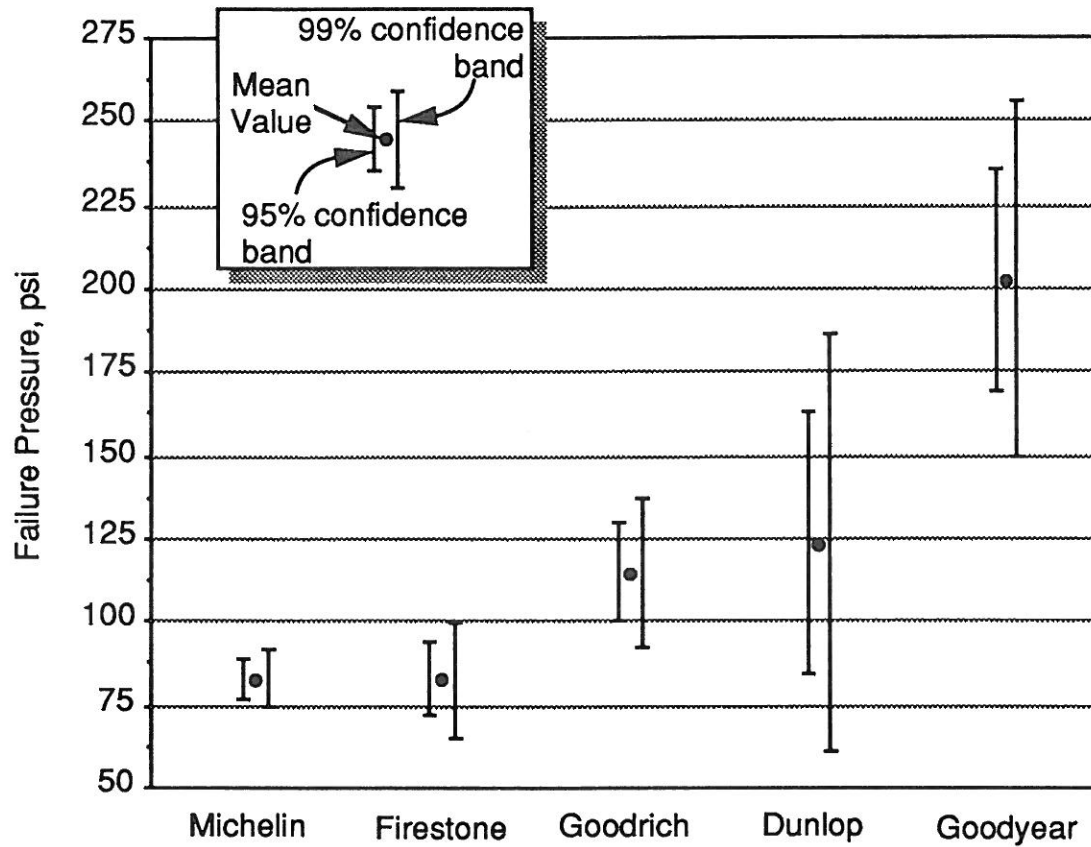


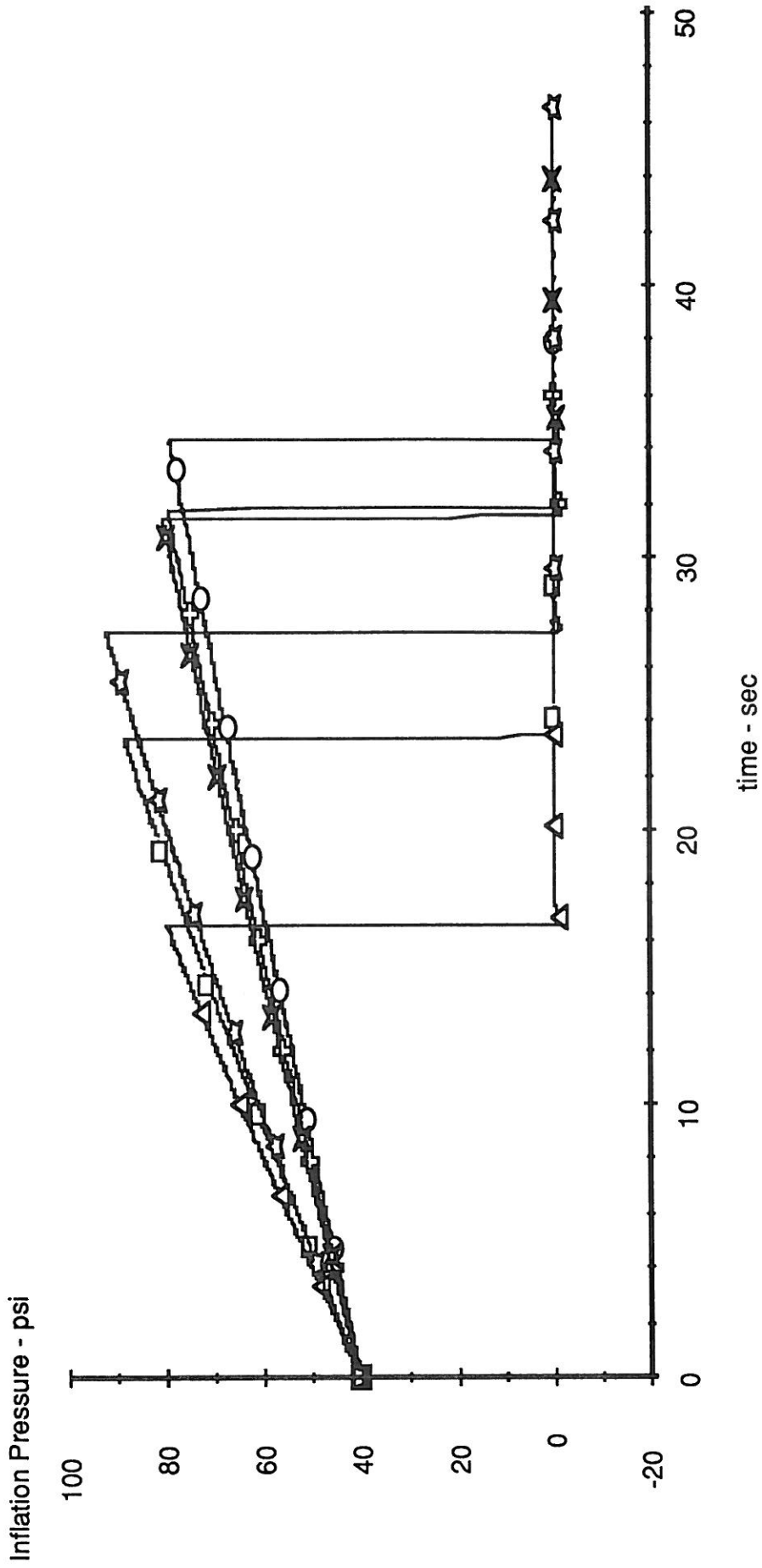
Figure 2. Failure Pressures by Tire Make
—The Mean Values and their 95% and 99%
Confidence Bands from Six Trials of Each Make—



Data Appendix

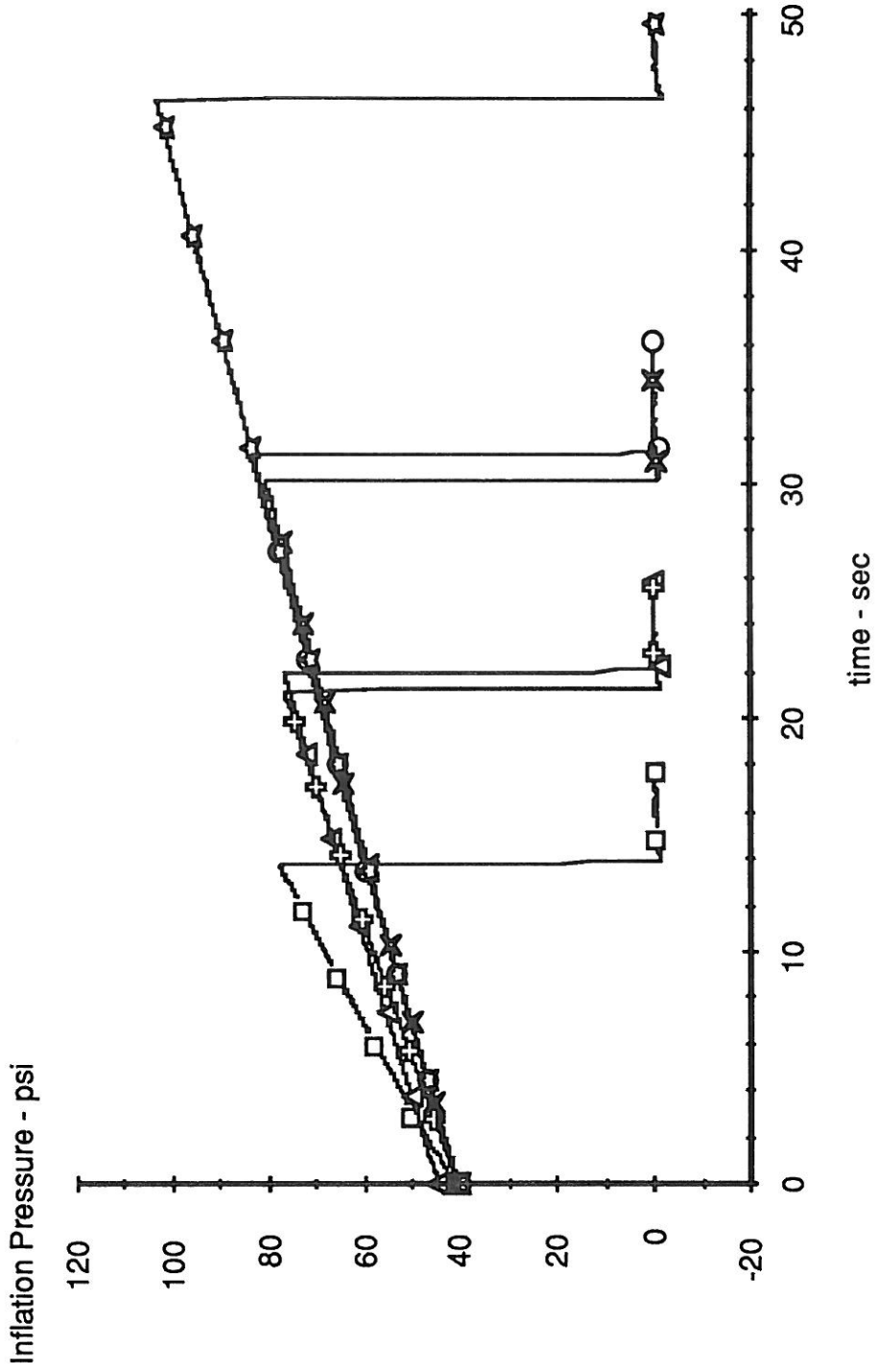
Michelin Radial XCH4 A11 Season LT215/85 R1b

- Test ID 8 Peak Pressure = 88.56 psi
- △— Test ID 10 Peak Pressure = 79.83 psi
- Test ID 11 Peak Pressure = 79.33 psi
- +— Test ID 12 Peak Pressure = 79.67 psi
- x— Test ID 13 Peak Pressure = 80.69 psi
- ☆— Test ID 14 Peak Pressure = 92.25 psi



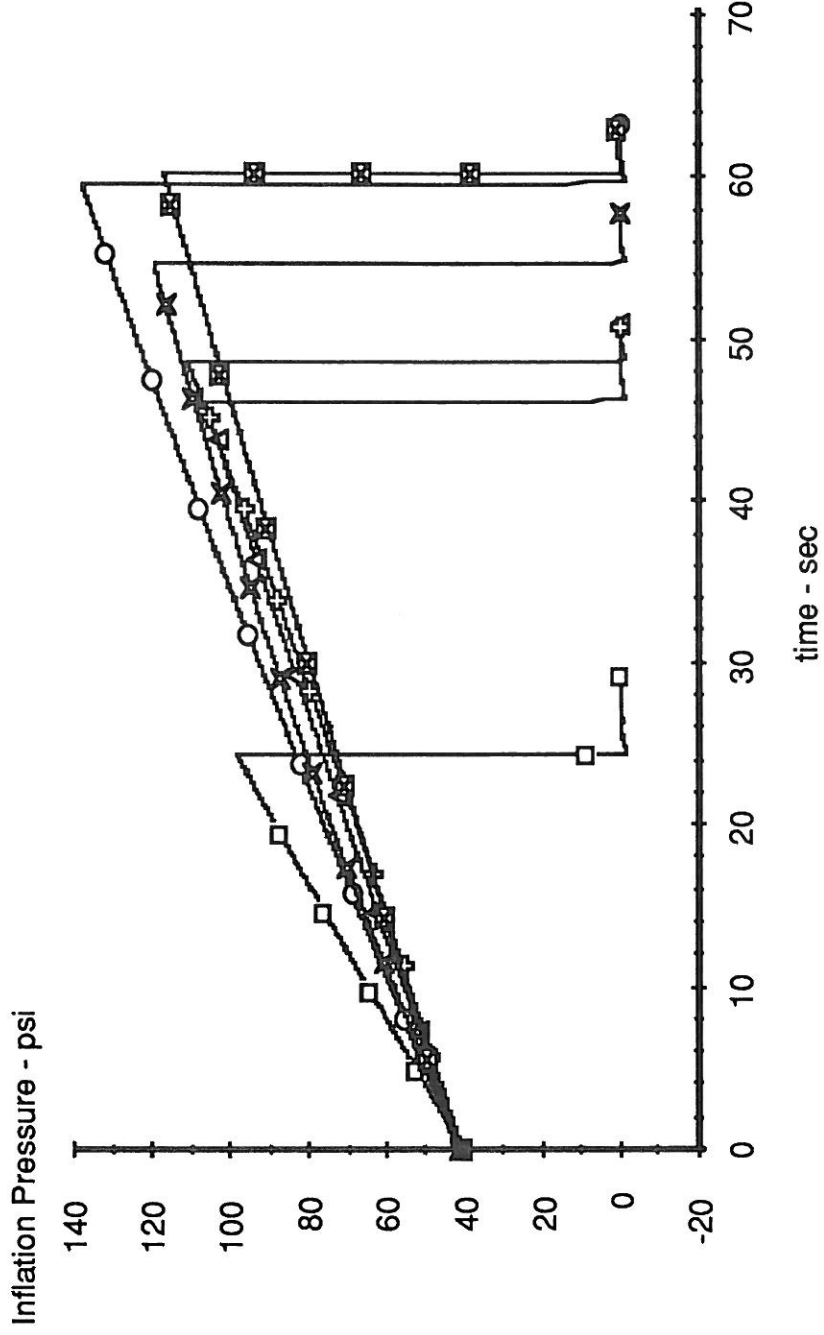
Firestone SteelTex Radial FSR LT215/85 R1b

- Test ID 15 Peak Pressure = 77.80 psi
- △— Test ID 21 Peak Pressure = 76.77 psi
- Test ID 22 Peak Pressure = 83.75 psi
- ⊕— Test ID 23 Peak Pressure = 76.94 psi
- ×— Test ID 24 Peak Pressure = 80.48 psi
- ☆— Test ID 25 Peak Pressure = 103.64 psi



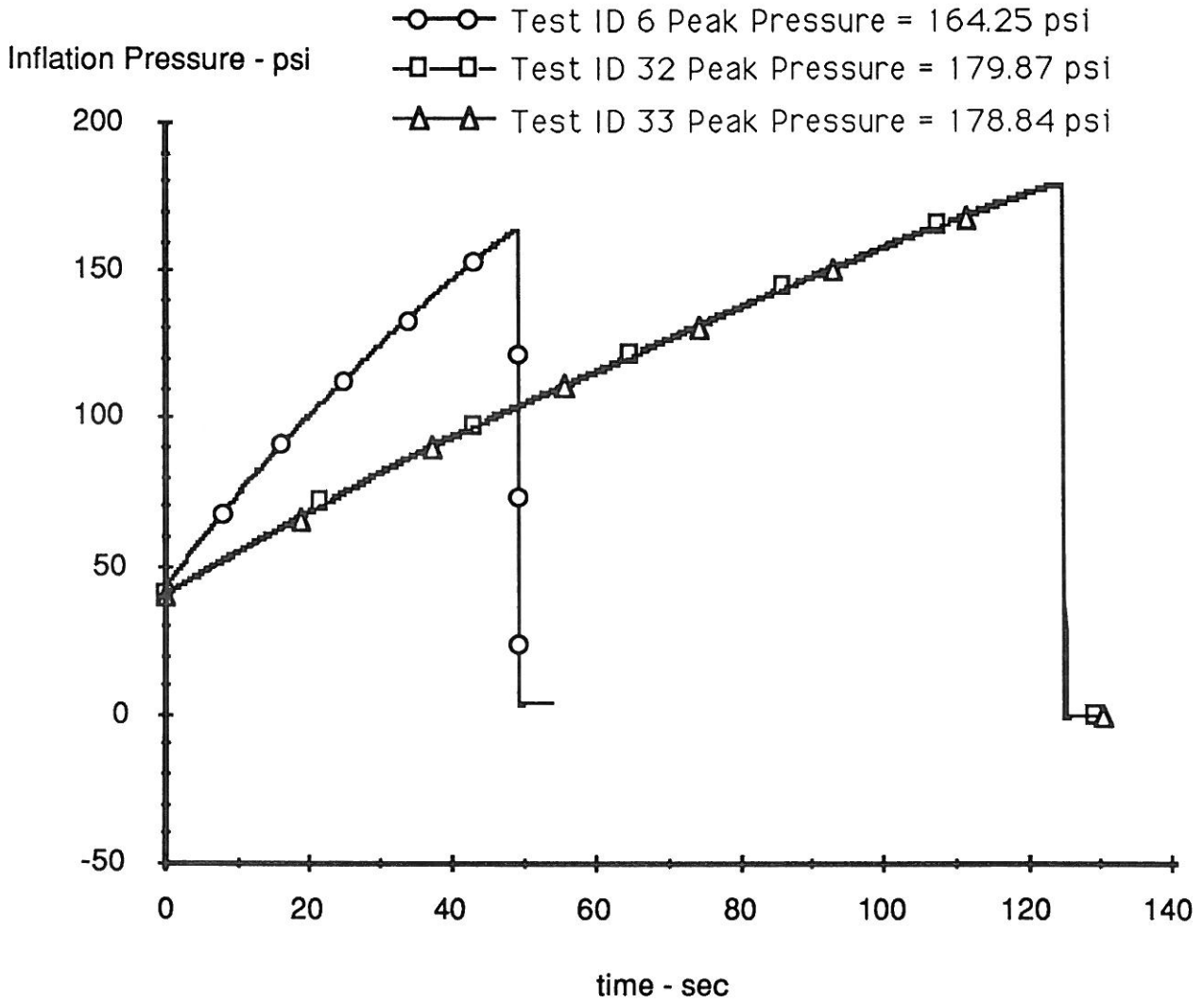
BF Goodrich The Edge LT215/85 Rib

- Test ID 9 Peak Pressure = 98.35 psi
- ▲- Test ID 26 Peak Pressure = 106.34 psi
- Test ID 27 Peak Pressure = 137.95 psi
- ◆- Test ID 28 Peak Pressure = 110.98 psi
- ✕- Test ID 29 Peak Pressure = 119.68 psi
- Test ID 30 Peak Pressure = 116.73 psi



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GoodYear Wrangler LT LT 215/85 Rib



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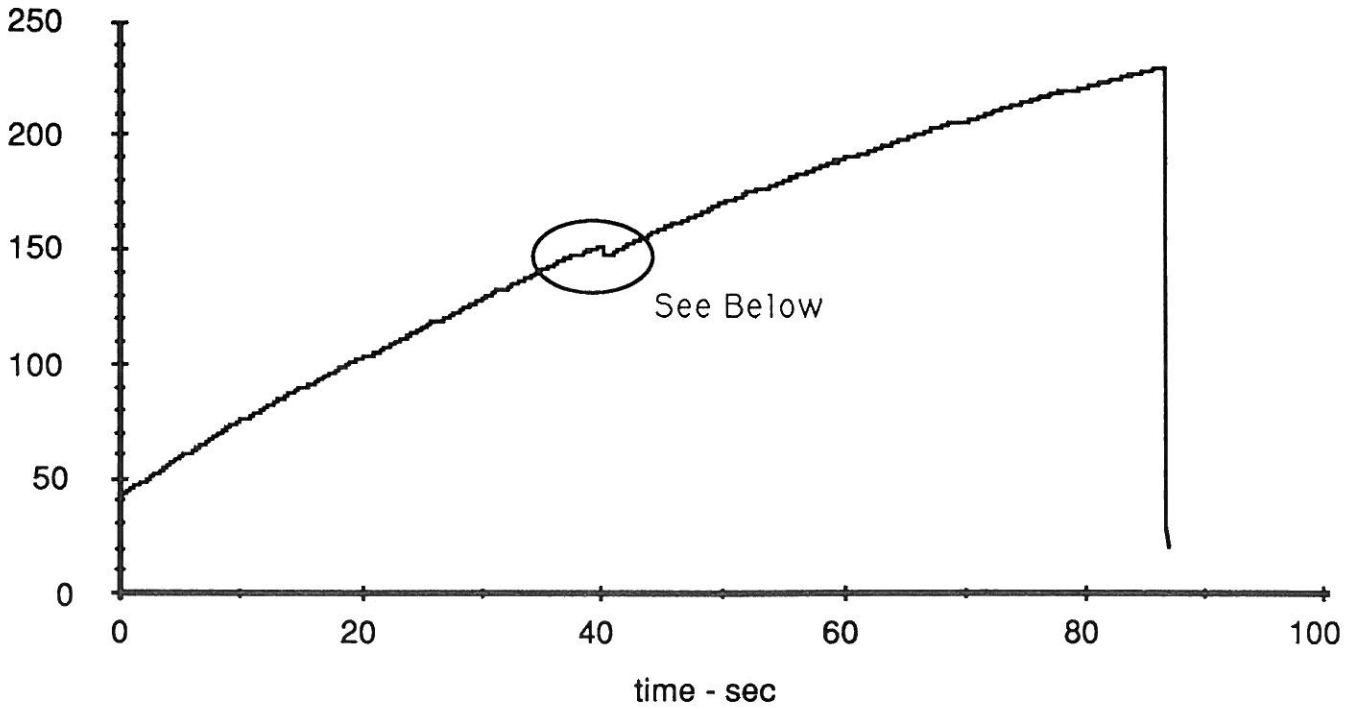
GoodYear Wrangler LT LT 215/85 R1b

Peak Pressure = 229.86 psi

Popped Pressure = 152.057 psi

Test ID 5

Inflation Pressure - psi

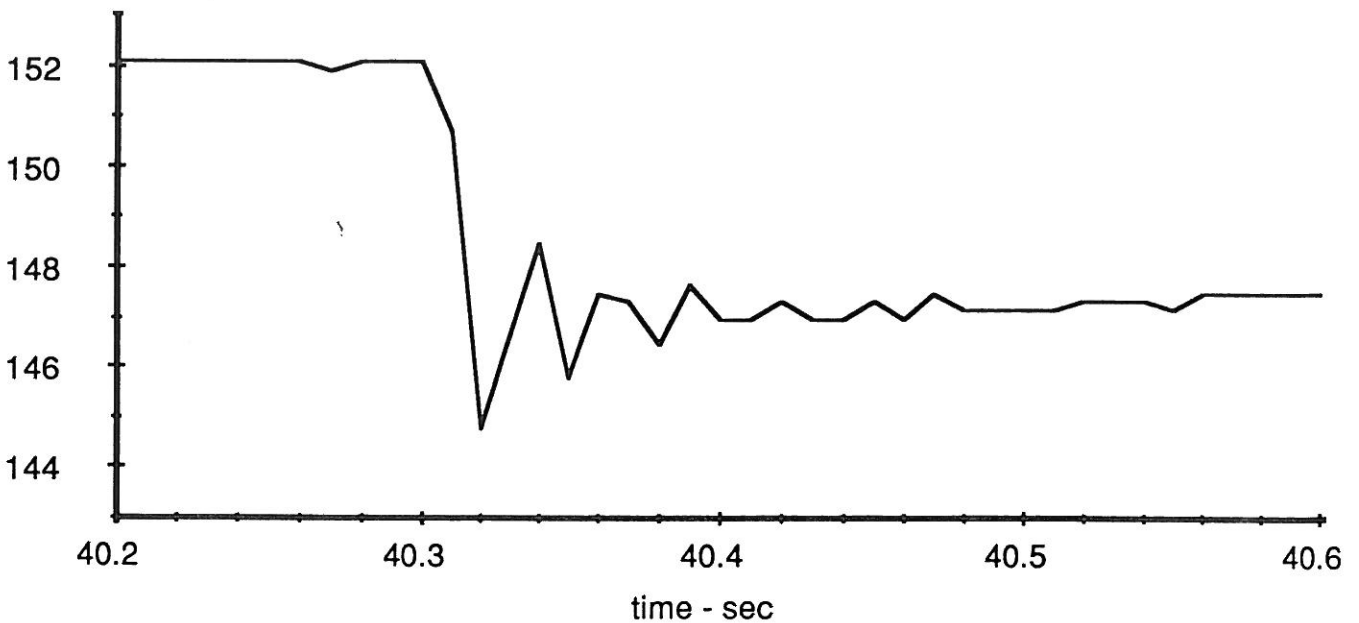


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UMTRI-1A

"Pop" Region

Inflation Pressure - psi



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UMTRI-1A

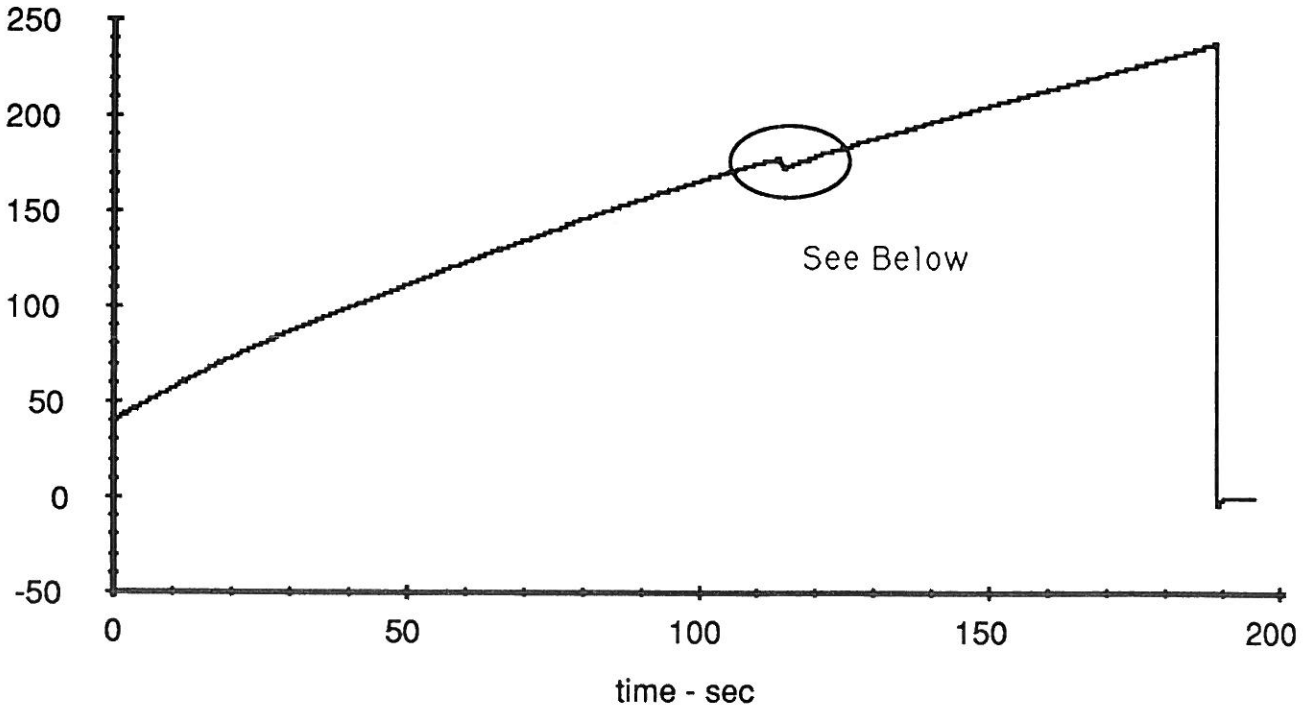
Goodyear Wrangler LT LT215/85 R1b

Peak Pressure = 237.19 psi

Popped Pressure = 177.47 psi

Test ID 34

Inflation Pressure - psi

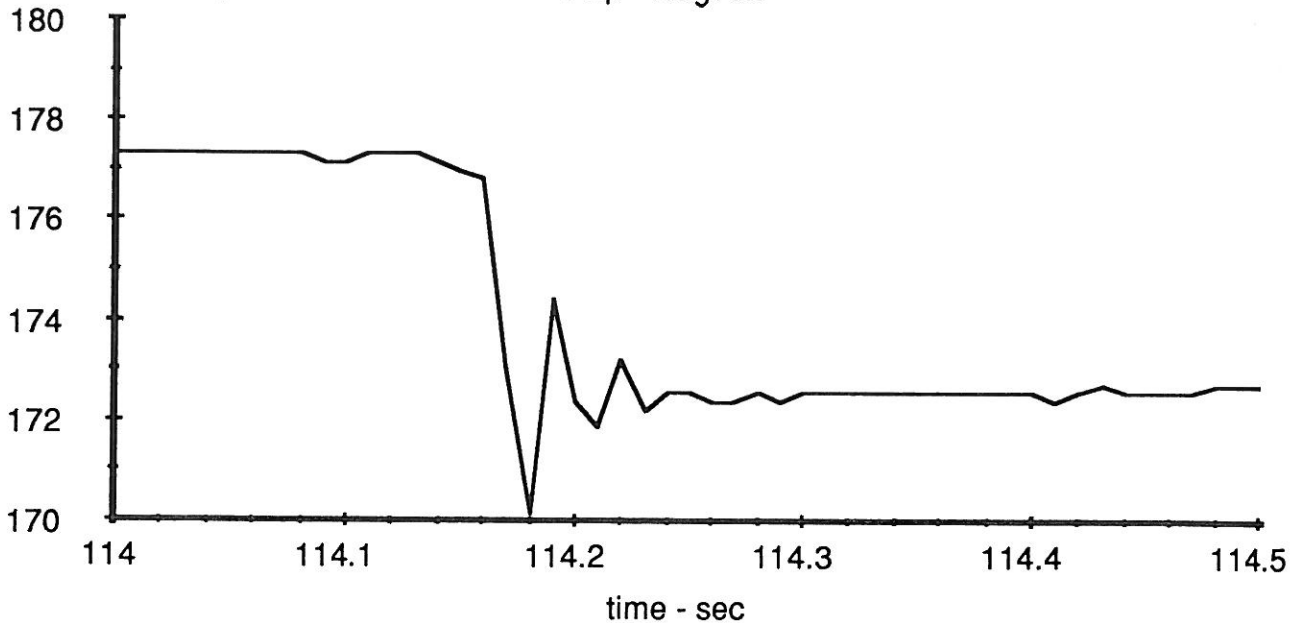


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UMTRI-6A

Inflation Pressure - psi

"Pop" Region



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UMTRI-6A

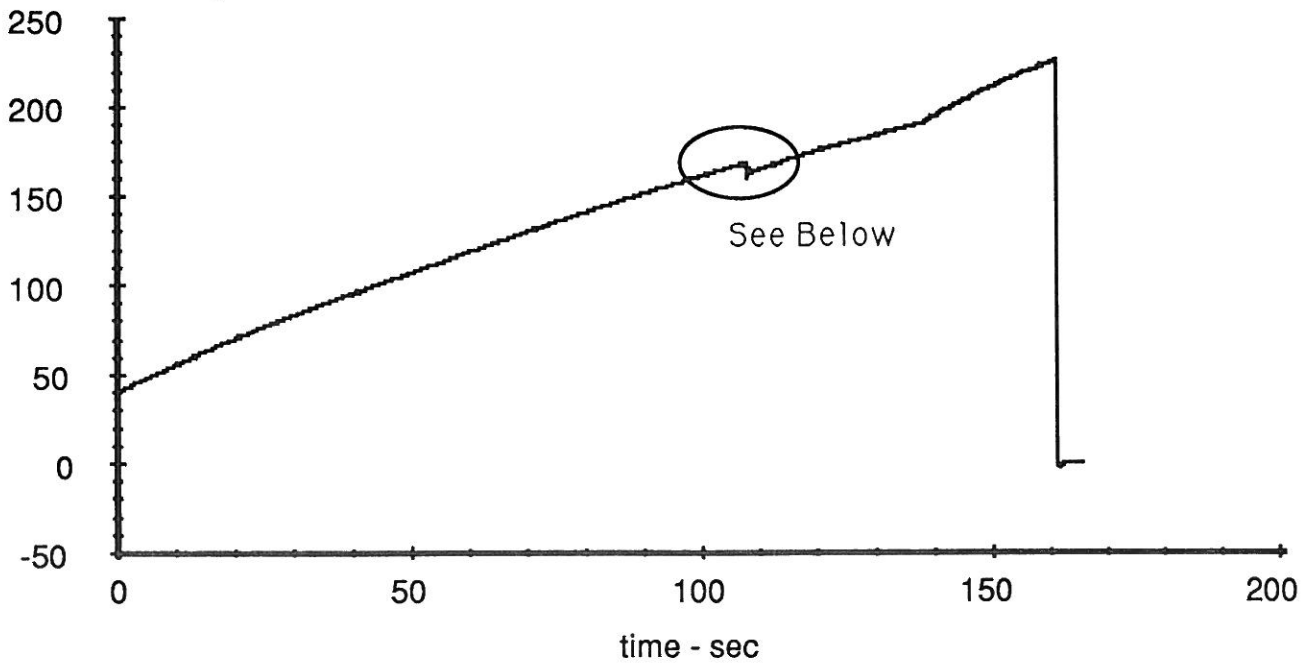
GoodYear Wrangler LT LT215/85 Rib

Peak Pressure = 226.1 psi

Popped Pressure = 168.26 psi

Test ID 31

Inflation Pressure - psi

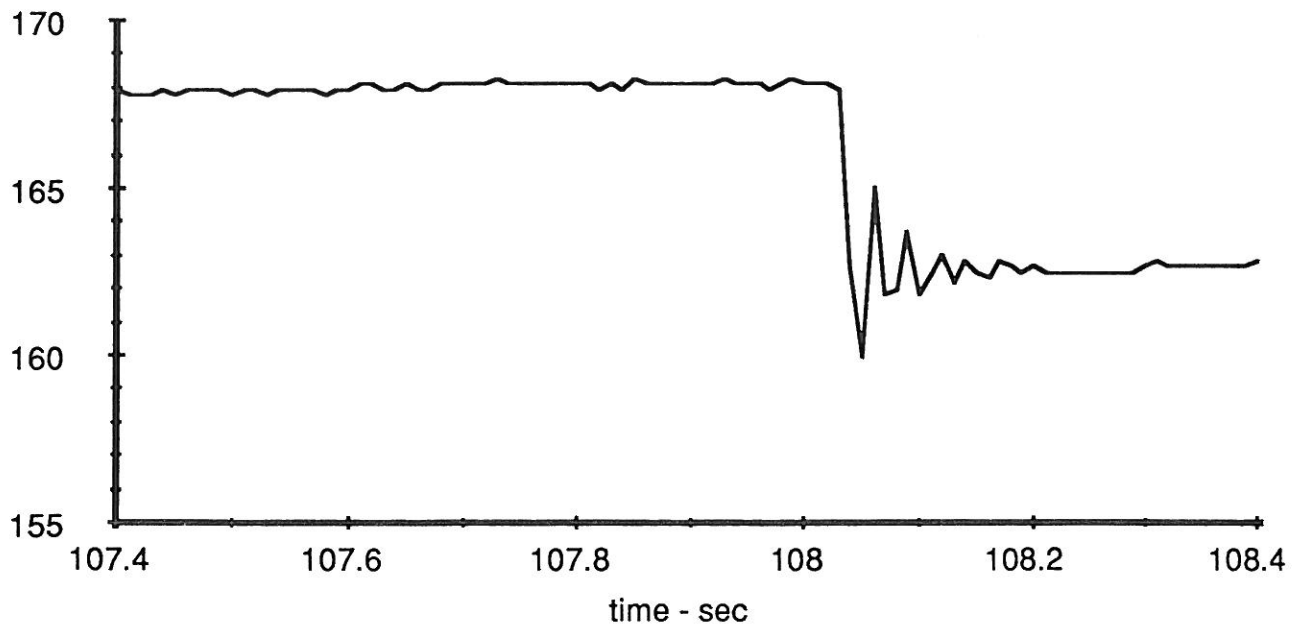


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UMTRI-3A

"Pop" Region

Pressure 1 - PSI



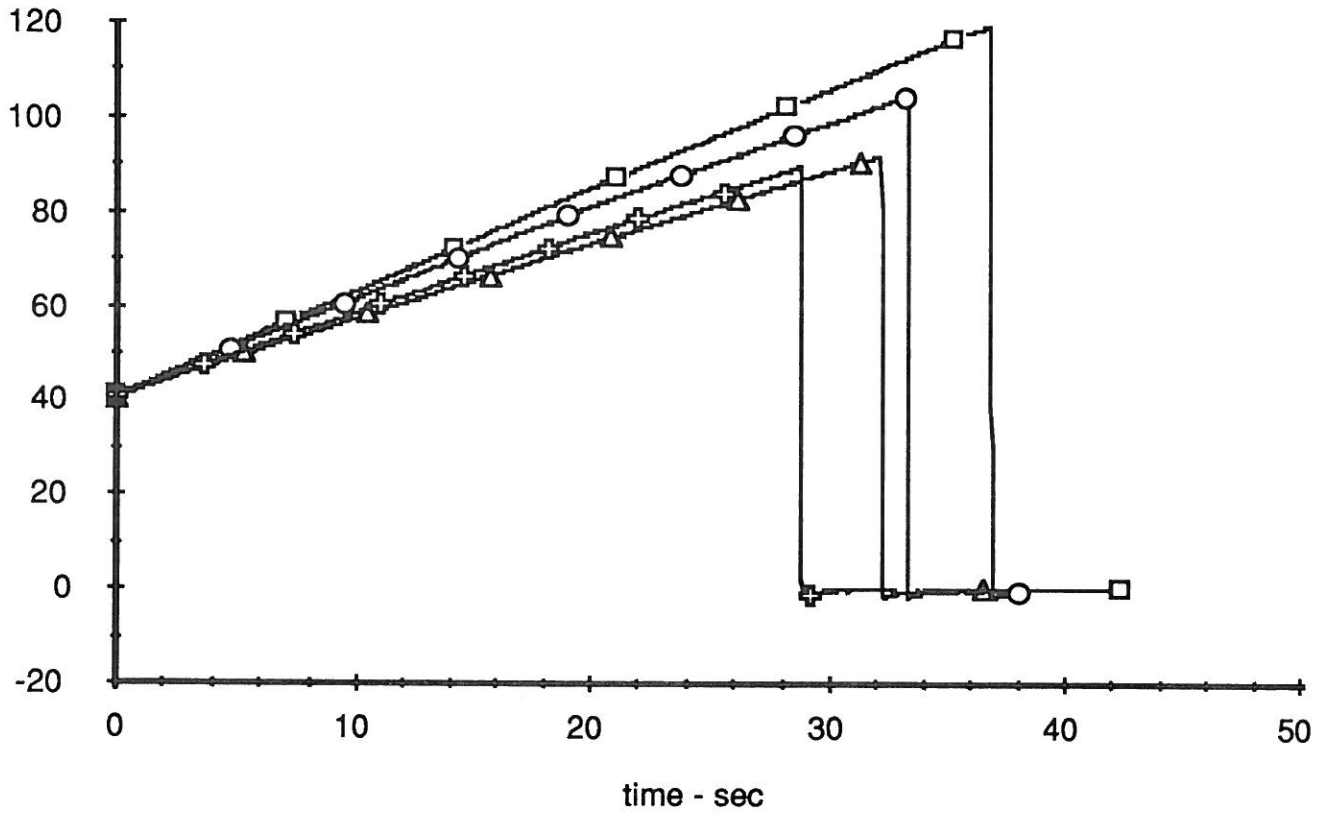
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UMTRI-3A

Dunlop A/P Radial Rover LT215/85 R1b

- Test ID 7 Peak Pressure = 118.83 psi
- △—△— Test ID 16 Peak Pressure = 91.75 psi
- Test ID 17 Peak Pressure = 104.33 psi
- +—+— Test ID 19 Peak Pressure = 89.29 psi

Inflation Pressure - psi



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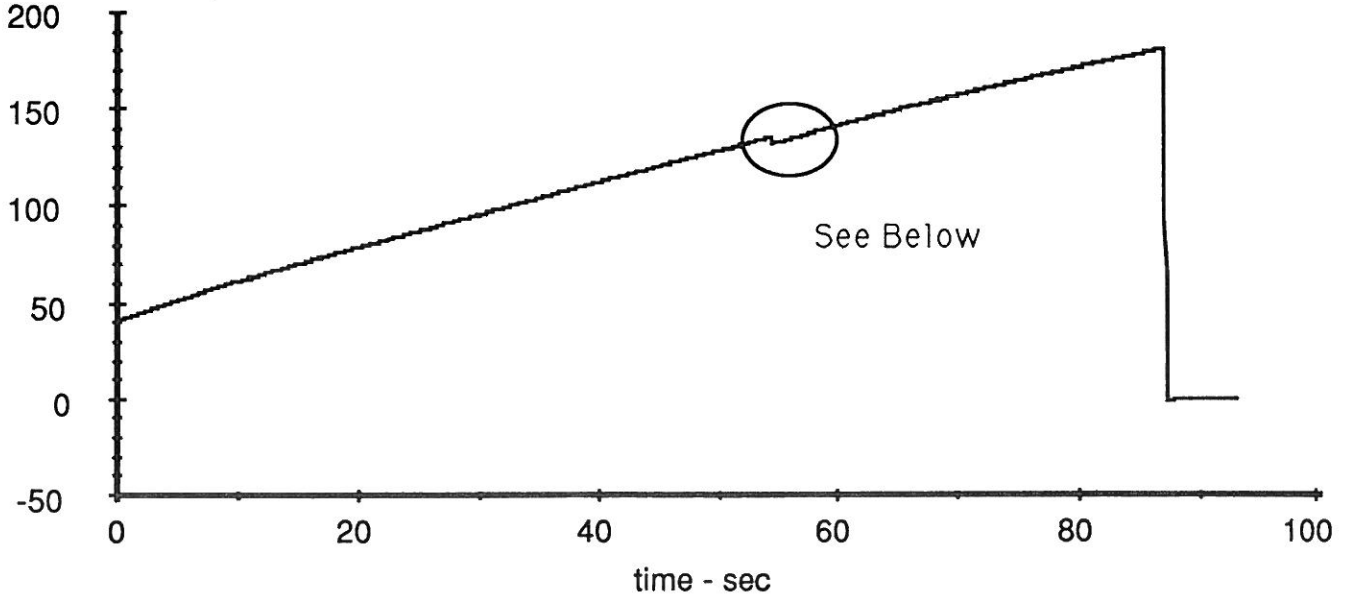
Dunlop A/P Radial Rover LT215/85 Rib

Peak Pressure = 181.02 psi

Popped Pressure = 135.41 psi

Test ID 18

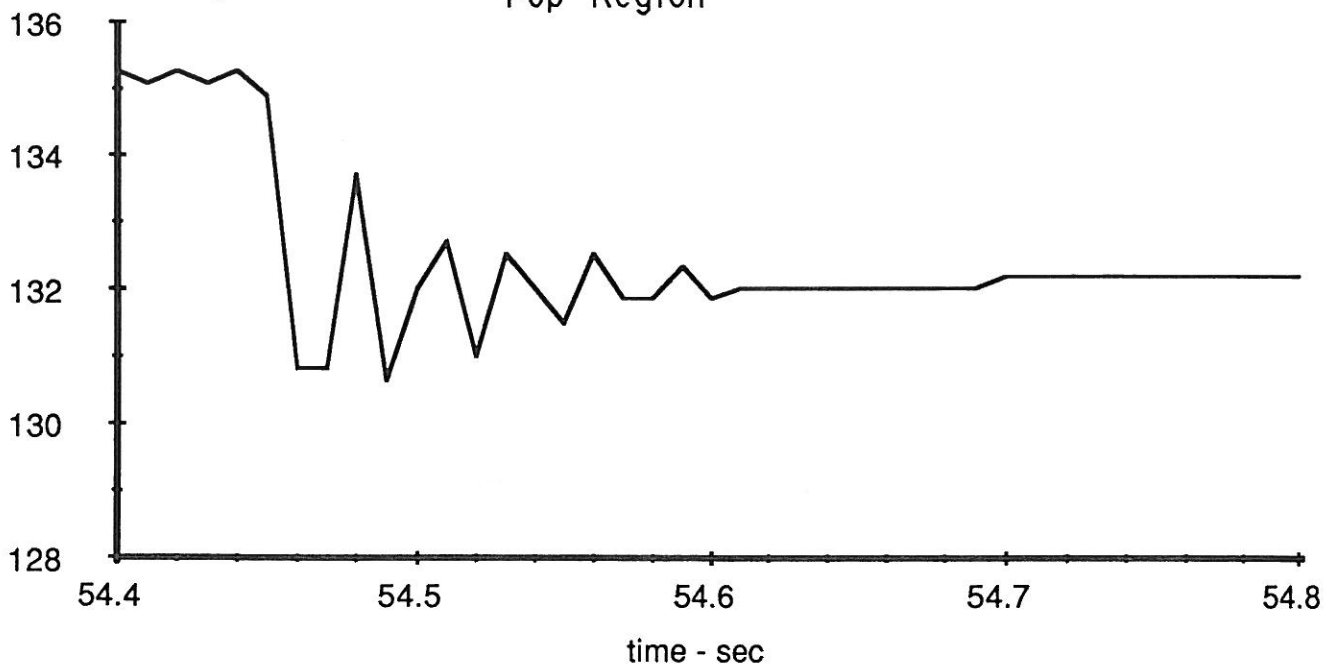
Inflation Pressure - psi



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UMTRI-27A

Inflation Pressure - psi



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UMTRI-27A

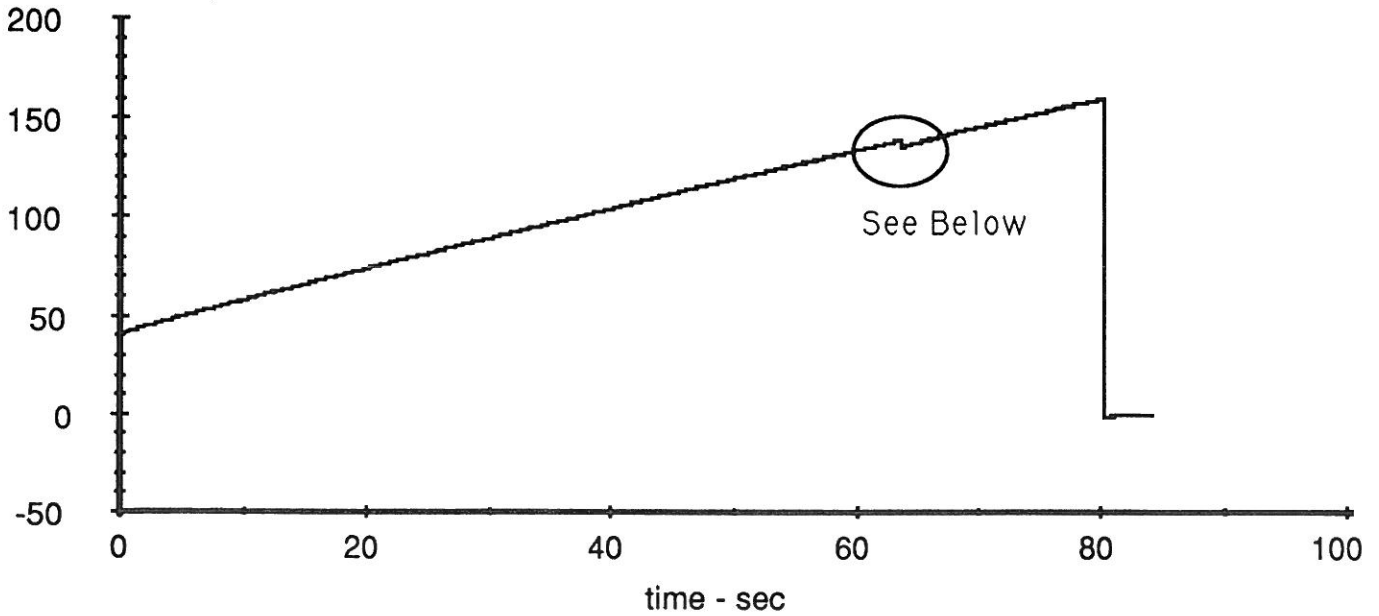
Dunlop A/P Radial Rover LT215/85 R1b

Peak Pressure = 159.92 psi

Popped Pressure = 138.64 psi

Test ID 20

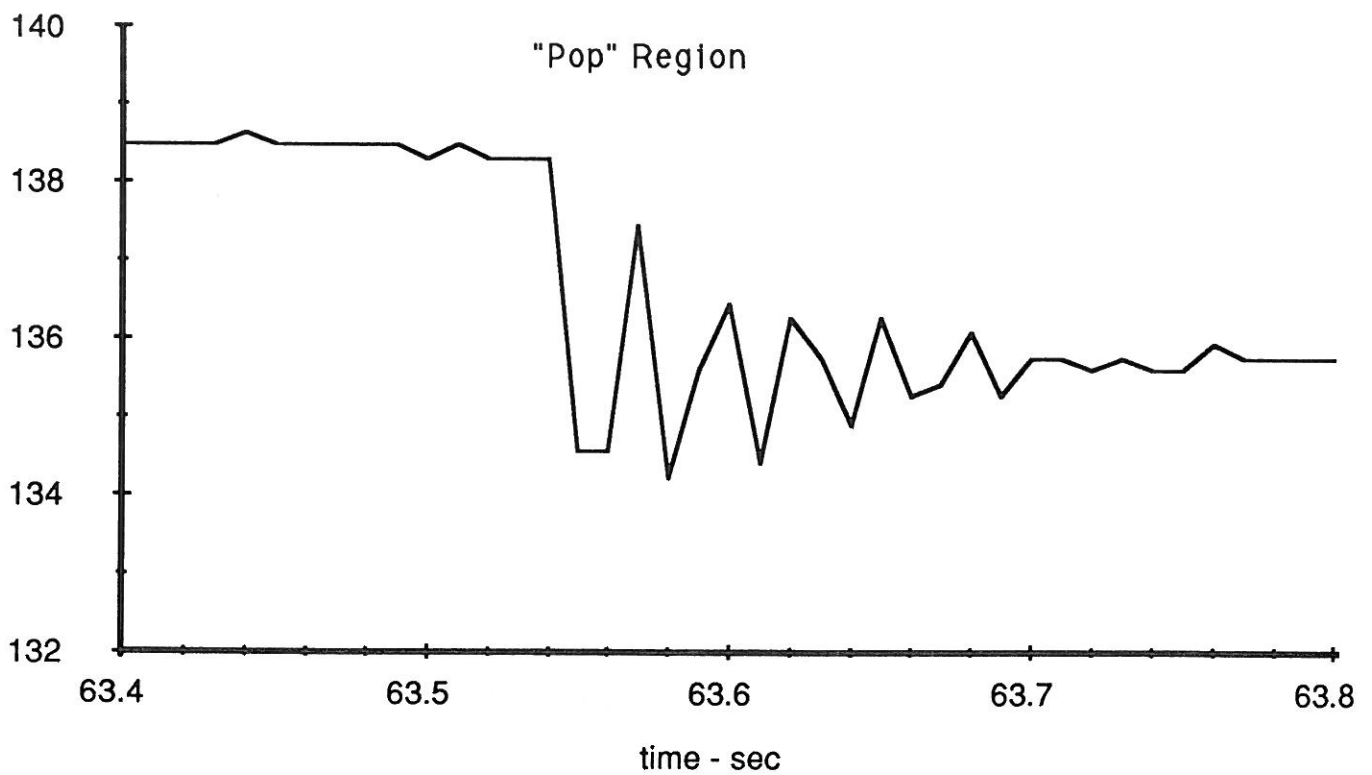
Inflation Pressure - psi



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UMTRI-30A

Inflation Pressure - psi



05/25/90 14:54:38 POP TEST

UMTRI-30A