FSAE TIRE TEST CONSTORTIUM DVD

From: Edward M. Kasprzak, FSAE TTC Co-Director
To: FSAE TTC members
Date: 15 March 2006

This document describes the contents of the DVD, provides a guide to the tests and acknowledges the people and organizations who have made this effort possible.

I. Acknowledgements

The FSAE Tire Test Consortium (FSAE TTC) has been founded, organized and lead by three Co-Directors:

Edward M. Kasprzak, University at Buffalo
Dr. Bob Woods, University of Texas, Arlington
Denny Trimble, University of Washington

My personal thanks to my co-directors for all their time and hard work.

The FSAE TTC received support from the following people and organizations:

Doug Milliken—FSAE Judge and Vice President of Milliken Research Associates. Doug Milliken continues to independently oversee the FSAE TTC finances and has contributed considerable time and effort to the consortium—above and beyond the call of duty. He has also donated a model of the data (MRA Nondimensional Tire Model), which is included on this DVD.

Mike Stackpole—Stackpole Engineering Services. Mike Stackpole has donated a Pacejka '96 model of the data, included on this DVD.

The Goodyear Tire and Rubber Company once again donated tires and shipped them to Calspan at no cost to the FSAE TTC.

Hoosier Racing Tire once again donated tires and shipped them to Calspan at no cost to the FSAE TTC.

Frisby's Performance Tire (www.frisbyracetire.com) provided the FSAE TTC with a discount on the Avon tires purchased for this round of tests.

Calspan Tire Research Facility (TIRF). Thanks to Dave Gentz, George Tapia, Sam Pugliese and everyone at Calspan for making this tire test possible. Calspan entered this project with a "What can we

do for the Formula SAE students?" attitude. They were easy to negotiate with and gave the consortium a substantial price break (they didn't turn a profit on this project). Everyone worked just as hard on this project as they do with their corporate and professional racing customers, and the staff went out of their way to accommodate FSAE students who attended the test. The Calspan Tire Research Facility is a top-notch operation—display your Calspan decal with pride.

II. Guide to the Tests

The second round FSAE TTC tests conducted in early February 2006 are a continuation of Calspan TIRF project number "1051". You will see this number throughout the data files.

Most of the data on this DVD is referenced by "run number". Each time a new tire or test sequence is started on the testing machine at Calspan TIRF a run number is assigned, starting with "1" at the beginning of a project. Round 1 of our project included runs 1-21, and Round 2 included runs 22-40. Runs 1, 2, 11 and 22 do not have data supplied since they were either tests to check the equipment or tests where a mistake was made in running the test.

As a result, a typical output file might be named "1051run3.dat", which is the third run (test) of our project.

The following table relates run numbers to the tires tested in Round 2:

Test	Tire	Test Type
Run 23	Goodyear 18x6.5-10 -- Tire 32	Lateral Force I
Run 24	Goodyear 18x6.5-10 -- Tire 33	Lateral Force II
Run 25	Hoosier 20.5x7.0-13 -- Tire 37	Lateral Force I
Run 26	Hoosier 20.5x7.0-13 -- Tire 38	Lateral Force II
Run 27	Hoosier 20.5x6.0-13 -- Tire 41	Lateral Force I
Run 28	Hoosier 20.5x6.0-13 -- Tire 42	Lateral Force II
Run 29	Avon 6.2/20.0-13 -- Tire 45	Lateral Force I
Run 30	Avon 6.2/20.0-13 -- Tire 46	Lateral Force II
Run 31	Avon 7.2/20.0-13 -- Tire 51	Lateral Force I
Run 32	Avon 7.2/20.0-13 -- Tire 52	Lateral Force II
Run 33	Hoosier 20.5x7.0-13 -- Tire 39	Longitudinal Force, 12 psi
Run 34	Hoosier 20.5x7.0-13 -- Tire 39	Longitudinal Force, 8 psi
Run 35	Hoosier 20.5x6.0-13 -- Tire 43	Longitudinal Force, 12 psi
Run 36	Hoosier 20.5x6.0-13 -- Tire 43	Longitudinal Force, 8 psi
Run 37	Avon 6.2/20.0-13 -- Tire 47	Longitudinal Force, 12 psi
Run 38	Avon 6.2/20.0-13 -- Tire 47	Longitudinal Force, 8 psi

Run 39	Avon 7.2/20.0-13 -- Tire 53	Longitudinal Force, 12 psi
Run 40	Avon 7.2/20.0-13 -- Tire 53	Longitudinal Force, 8 psi

The Test Types are as follows:

Lateral Force I:

- Static (non-rolling) spring rate test on brand new tire
- Dynamic (rolling) spring rate test on brand new tire. Speed at 25 mph for the rest of the test.
- Tire Break-in. Oscillation in slip angle and inclination angle for appx. 3 minutes.
- Conditioning Sweeps. Two steers to large slip angles at 250 lb. load to finish tire break-in.
- Dynamic spring rate test on tire after break-in.
- Slip angle sweeps at various loads and inclination angles, 12 psi., 0 slip ratio.
  - Inclination angles: 0, 1, 2, 3, 4 deg.
  - Loads: 350, 250, 150, 50, 450 lb.
- Post-test dynamic spring rate (worn tire).

Lateral Force II:

- Static (non-rolling) spring rate test on brand new tire
- Dynamic (rolling) spring rate test on brand new tire. Speed at 25 mph for the rest of the test.
- Tire Break-in. Oscillation in slip angle and inclination angle for appx. 3 minutes.
- Conditioning Sweeps. Two steers to large slip angles at 250 lb. load to finish tire break-in.
- Dynamic spring rate test on tire after break-in.
- Slip angle sweeps at various loads and pressures, 0 deg. inclination angle, 0 slip ratio.
  - Pressures: 8, 10, 12, 14, 16 psi.
  - Loads: 350, 150 lb.
- Dynamic spring rate test for every pressure performed between slip angle sweeps
- Post-test dynamic spring rate (worn tire).

Longitudinal Force:

- Tire Break-in. Oscillation in slip angle and inclination angle for appx. 3 minutes.
- Conditioning Sweeps. Two cycles to large slip angles at 250 lb. load to finish tire break-in.
- Slip ratio sweeps at various loads, 12 psi, 0 slip angle
  - Loads: 350, 250, 150, lb.
  - Inclination Angles: 0, 2, 4 psi
- Slip ratio sweeps at various loads, 8 psi, 0 slip angle
  - Loads: 350, 250, 150, lb.
  - Inclination Angles: 0, 2, 4 psi

- Slip ratio sweep at 250 lb. to very large ± slip ratio (almost locked, spinning)

III. DVD Contents

The contents of the DVD are now listed. This list is arranged according to the folders on the DVD.

Top Level

- PDF describing the contents of the DVD
- PDF containing the text of the FSAE TTC website as it stood when you registered
- PDF stating the terms of use of this DVD's contents. *Read this document carefully.*
- Excel spreadsheet of summary tables provided by Calspan

The "Summary Tables" spreadsheet is provided by Calspan. It contains a list of the runs, run conditions and tires used for the tests. Tables of "reduced parameters", including tire spring rates and cornering stiffnesses, are provided. Tire carcass temperature measurements, taken with a probe immediately following the end of each test, are reported.

fromCalspan

- A cover letter describing what was provided to the FSAE TTC (all contents appear on this DVD)
- Calspan TIRF logos (to make your own decals)
- Command files for the tests
- The TIRF website
- Reference documents on TIRF capabilities

Currently the TIRF website is being absorbed into a reworked Calspan website and is not available on the internet. The website included still shows the logos of their previous name, Veridian.

fromMillikenResearchAssociates

- A cover letter describing the contents provided by MRA—please read this for more information
- Five .mat (Matlab) files containing MRA Nondimensional Tire Model coefficients
- Two .p (Matlab) files containing the MRA Nondimensional Tire Model expansion
- One .m file which shows how to call the expansion routines

fromStackpoleEngineeringServices

- A single PDF containing the coefficients for Pacejka ’96 models of the measured data, a statement of model equations and a discussion of the raw data.

RawData_____

Four folders, each containing raw data files in the following formats:

- ASCII (plain text, space delimited), Metric
- ASCII (plain text, space delimited), USCS
- ASCII (plain text, space delimited), Mixed ...used by Stackpole Engineering Services
- Matlab (.mat format), USCS

TestVideos

Video of each run is provided. Files are labeled by their run number. All lateral force tests contain the entire warm-up sequence. For the longitudinal (drive/brake) runs the video starts at the conclusion of the conditioning sweeps.

IV. Questions/Comments

Please direct your questions/comments to Edward M. Kasprzak, kasprzak@localnet.com