DECLARATION OF BRIAN G. McHENRY

RE: **State of Washington vs. Michael Sipin**
King County Cause No. 00-1-09336-1 KNT
SUPERIOR COURT OF THE STATE OF WASHINGTON
COUNTY OF KING

Brian G. McHenry declares:

1. I am a Research Associate with more than 20 years experience in the fields of highway safety and accident reconstruction. I have been employed as a Research Associate, Accident Reconstructionist, Computer Consultant and Vice President by McHenry Consultants, Inc. a North Carolina Corporation that was founded in 1980. My employment duties include investigation and documentation of evidence in highway accidents, and reconstruction of accidents through the application of analytical and experimental techniques to the accident evidence. As part of my employment I have developed, refined and evaluated mathematical models and computer simulations of car-to-car collisions, single vehicle accidents and of the corresponding occupant kinematics as part of government sponsored research with the Federal Highway Administration (FHWA), National Highway Traffic Safety Administration (NHTSA), and National Traffic Safety Board (NTSB) as well as state agencies and through related internal research. Through the course of my career I have published over 16 technical papers and reports related to the analytical modeling and simulation of motor vehicle collisions, vehicle dynamics and occupant kinematics.
2. I am fully familiar with the state-of-the-art of computer applications related to accident reconstruction, vehicle dynamics and occupant simulation.
3. I am fully familiar with the technical capabilities and limitations of the PC-CRASH computer program.
4. I have been asked by Mr. Michael Sipin to render my professional opinion with regard to the validity and reliability of the opinion of the prosecution's expert, Ron Heusser, including his analytical procedures, the underlying data that he has relied upon, and the reliability and general acceptance of the PC-Crash computer simulation program that he used in this case to form his opinion.

5. The PC-CRASH program (**i**) is a recent (1996) addition to the software programs available for accident reconstruction.
    a. The PC-CRASH program is a momentum based program.
    b. The PC-CRASH program includes the assumption that momentum is instantaneously exchanged at a user specified instant during the collision contact.
    c. In the real world the exchange of momentum during an automobile collision takes between 50 and 150 milliseconds.
    d. In automobile collisions and particularly in occupant simulation models, the duration and wave form of the collision force during the momentum exchange can significantly affect the simulated behavior (***ii***, ***iii***)
    e. To accommodate the assumed instantaneous exchange of momentum, the PC-CRASH program requires that the user specify for each and every simulated collision the location, direction (X, Y & Z) and magnitude of the force during the collision.
    f. The limited validations of PC-CRASH are based on comparisons of the results of PC-CRASH with known results of full-scale tests where guidance was available in choosing the location, direction and magnitude of the collision force during the impact speed-change to provide the best match.
    g. There have been no independent verifications of the validity of results of PC-CRASH program in general applications wherein the results are not known prior to the application of PC-CRASH.
    h. PC-CRASH and other software programs related to accident reconstruction should be used to test and refine the results of a conventional accident reconstruction analysis, not create the sole basis for conclusions.

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i Cliff, Montgomery, "Validation of PC-Crash—A momentum-based accident reconstruction program", SAE Paper 960885
ii McHenry "Analysis of the Dynamics of Automobile Passenger-Restraint Systems", 7th Stapp Car Conference Proceedings, SAE, 1966
iii Grimes, Lee, "The Effect of Crash Pulse Shape on Occupant Simulations", SAE Paper 2000-01-0460

6. The 11 MPH impact speed change specified at the mailbox and the 34 MPH impact speed change specified at the tree by Mr. Huesser were arbitrary inputs that were not determined or calculated by the PC-CRASH computer program:
    a. The PC-CRASH program does not include any damage analysis or ability to predict the damage. This is inconsistent with Mr. Heusser's related testimony (***iv***)
    b. There is an option in PC-CRASH to add an arbitrary CRASH sequence which "allows a speed change to be specified anywhere along a vehicle's path" (***v***)
    c. The speed changes quoted by Mr. Huesser were specified by Mr. Heusser through the optional CRASH sequence at the mailbox and at the tree and, therefore, were arbitrary.
    d. Mr. Heusser did not make any damage measurements (***vi***)
    e. All damage analysis procedures require the use of damage measurements.
    f. The location of the mailbox post in the PC-CRASH simulation is not at the center of the post hole as indicated the drawing provided by Heusser to the court. (***vii***)
7. The fact that a computer program is based on or includes the laws of physics is insufficient in itself to validate a program for general use or for use in any particular individual application.
    a. The type of accident and/or occupant simulation must be demonstrated by comparison of predicted and experimental results to be an appropriate application of the program.
    b. The PC-CRASH program has never been validated or even demonstrated in the literature for pole, mailbox and/or tree impacts.
    c. The PC-CRASH Multi-Body option has been demonstrated only to correlate with the gross occupant kinematics of pedestrian-vehicle

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iv Pre-trial testimony, P34, Trial Testimony p27 "match of physical damage", p34 "indicates Yes that he was able to view the damage as consistent with the BMW in this case"
v PC-CRASH Operating Manual, Version 6.0, July 1999 , p 181
vi Heusser Trial Testimony, 7/19/02, p17 did not measure width of pole impact on car. Did not measure depth of pole impact. p22 did not measure the dent itself in the car,
vii CAD File provided on CD in directory TotalStationData entitled 00-070495 DIAGRAM FOR DIST.FCW showed the pole offset from the center of the hole left after the removal of the mailbox post and anchor.

impacts.

d. The PC-CRASH Multi-Body option has never been validated or demonstrated to correlate with the detailed kinematics of occupants in the interior of vehicles.

e. The Human Biomechanics and Simulation Standards Committee of the Society of Automobile Engineers (SAE) created a proposed Validation Index which requires a quantitative comparison of output data generated by mathematical models with the results of tests (***viii***).

f. The multi-body option of the PC-CRASH program has never been demonstrated to have any quantitative or qualitative comparison with occupant motions within the vehicle compartment.

8. The PC-CRASH application by Mr. Heusser includes problems which indicate that it is inconsistent with the laws of physics and inconsistent with his own testimony:

   a. Printouts provided to the court (**ix**) by Mr. Heusser indicate a Separation Speed of **1114.8 MPH** at time=4.13 (pg. 2), **290.1 MPH** at time=5.06 sec (pg. 4), **241.3 MPH** at time=5.07 sec (pg. 5), **88.6 MPH** at time=5.34 sec (pg. 7), **108.8 MPH** at time=5.38 sec (pg. 8), **132.1 MPH** at time=5.44 sec (pg. 9), **127.2 MPH** at time=5.54 sec (pg. 5.54 sec). These invalid numbers indicate that there are some problems with the PC-CRASH analysis presented to court which indicate that the PC-CRASH analysis does not obey the laws of physics.

   b. Printouts provided to the court (**ix)** indicate a friction coefficient (mu) of 1.00 for the entire simulation which contradicts the testimony of Mr. Heusser.

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viii Robbins, Restraint Systems Computer Modeling and Simulation State of the Art and Correlation with Reality, SAE paper 891976

ix 14 page printout from Heusser dated 2/6/2002, "Simulation tracking over Scene Diagram, Vehicle Positions every 0.5 sec", Engineering Accident Analysis, C:\Cases\02 Car Cases\2cg-001\Final\BMWFinalOcc.pro

9. The use of the PC-CRASH program Multi-Body Option to predict the kinematics of the occupants in the subject accident constitutes a misrepresentation of the capabilities and validity of the PC-CRASH program and an inappropriate application of the PC-CRASH program. It is not in keeping with sound engineering practices and principles.
    a. The addition of a Multi-Body **Pedestrian** Model to PC-CRASH was first announced in publications in 1999 and 2000 (***x***,***xi***).
    b. The addition of an **occupant simulation model** to PC-CRASH was first announced in 2000 and was a subset of the MADYMO program(**xii**).
    c. In the version 6.2 Operating Manual of PC-CRASH of Nov 2001, the Multi-Body **Pedestrian** Model was changed to the Multi-Body **Option.** The multi-body option allowed the user to model occupants in the interior of the vehicle (***xiii***, ***xiv***).
    d. Mr. Heusser chose to use the Multi-Body Option of PC-CRASH to simulate the occupants in the subject accident.
    e. There have been only two papers published on the Multi-body Pedestrian Model of PC-CRASH (**x**, **xi)** and neither paper included any discussion of vehicle interior movements or any indication that the Multi-Body option could be used for the prediction of the movements of occupants within the interior of a vehicle.
    f. There are no published papers which demonstrate any correlation or validity of the PC-CRASH Multi-Body Model when it is used to simulate occupants within the interior of a vehicle.
    g. The use of the multi-body option of the PC-CRASH program by Mr.

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x Moser, Steffan, Kasanicky "The Pedestrian Model in PC-Crash – The introduction of a Multi Body System and its Validation", SAE paper 1999-01-0445
xi Moser, Hoschopf, Steffan, Kasanicky, "Validation of the PC-Crash Pedestrian Model", SAE paper 2000-01-0847
xii Steffan, Moser, Geigl, Motomiya,"Validation of the coupled PC-CRASH-MADYMO occupant simulation model", SAE Paper 2000-01-0471
xiii PC-CRASH Operating Manual, Version 6.0, July 1999 Chapter 7 was entitled **Pedestrian Model**, included presentation of the "multi-body systems" for pedestrian-vehicle impacts and described as 'with this extension, vehicle-pedestrian impacts and trajectories can be modeled in a similar manner as vehicle-vehicle incidents are'. CHAPTER 6 was entitled Occupant Simulation and presented the MADYMO option.
xiv PC-CRASH Operating Manual, Version 6.2, November 2001, Chapter 5 was entitled **Multibody Model** which is an extension of the previous Chapter 7. Description changed to include 'allow other multibody objects such as two wheeled vehicles, multiple multibody objects in one simulation, and multibody objects on 3D ground surfaces'

Heusser served as the basis for his opinion as to the identification of the driver (***xv***).

h. The vehicle specifications and data relied upon for this PC-CRASH application (Autostats, Canadian SPECS database and Automotive News (***xvi***)) do not include any detailed information on the vehicle interior measurements and properties (seats, dashboard, pillars, head rests, interior space, and location of shift lever).

i. The default interior used by Mr. Heusser to represent the BMW in the subject case in his PCCRASH simulation was a generic vehicle body and not substantially similar to the interior dimensions and properties of the subject vehicle.

j. Mr. Heusser's PC-CRASH occupant simulations do not include the significant interaction of the occupants with the dash and steering wheel and assembly (***xvii***) which would have acted to dramatically inhibit the movement and ejection of the driver of the vehicle.

k. In the occupant simulation, Mr. Heusser chose to treat the simulation of the occupants at the mailbox and at the tree as two totally separate events.

l. The initial positions and postures of the occupants assumed by Mr. Heusser at the start of the mailbox simulation and at the start of the tree impact simulation were identical and in a default "design" seated positions.

m. Prior to the impact with the mailbox post, the rapid vehicle rotation would have been expected to move the positions of the occupants from the default "design" seated positions.

n. As a result of the mailbox impact, and the movement of the vehicle between the mailbox impact and the tree impact the vehicle traversed a downslope, rotated significantly to permit dragging of the 3' mailbox concrete anchor which was of a size greater than the undercarriage height

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xv Report dated March 10, 2002 by Mr. Ronald B. Heusser entitled "Simulation of BMW/Mailbox/Tree Collision 02-CG-001" includes the statement "Through the use of the three dimensional computer simulation" and "the computer also found no appreciable occupant movement during the impact with the mailbox post" and "The collision with the tree ejected the driver".

xvi Heusser trial testimony, 7/19/02, p53

xvii In both occupant simulation videos the legs of the occupants can be seen to pass through the dash assembly.

of the vehicle (~1'), and which ripped components from under the vehicle, all of which would have moved the positions of the occupants from the default "design" seated positions.

o. During the approximately 0.84 seconds between the mailbox impact and the tree impact Mr. Heusser chose not to simulate the movement and responses of the occupants.

p. Mr. Heusser stated that the reason he chose not to simulate the movement between the mailbox and tree was "an issue of time on the computer and processing time we discussed about earlier" (***xviii***) The probable reason is that during a PC-CRASH multi-body simulation an erroneous separation of the joints and segments of the occupants and vehicle may occur due to the discrete nature of the integration procedure as well as due to numerical roundoff error (***xix***). This phenomenon can be seen during the longer tree impact simulation (***xx***).

q. The inputs used to describe the occupants of the vehicle in the PC-CRASH simulation are defaults based on the occupant weights and type (***xxi***)and which are most probably based on regression equations from anthropometric surveys and stereo photometric data (**xxii**, ***xxiii***)

r. There are vast differences in the proportions, musculature and mass distribution of different individuals. Regression equations can only roughly approximate the properties of an occupant or dummy in vehicle crash tests.

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xviii Trial Testimony, 7/18/02, p136

xix Pg 4, of **x**

xx The actual input file used by Mr Heusser to simulate the occupants at the mailbox was not provided to the court and therefore not available to permit a rerun of the simulation for a longer time period to demonstrate this probable PCCRASH error condition from occurring.

xxi Pre-Trial 6/26/02 p117 Computer program takes weight and then you supply the body type. and sizes based on weight and body types

xxii. Clauser, Charles E., Pearl E. Tucker, John T. McConville, Edmund Churchill, Lloyd L. Laubach, Joan A. Reardon, April 1972, "Anthropometry of Air Force Women," AMRL-TR-70-5, Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio

xxiii Snyder, R.G., Schneider, L.W., Owings, C.L., Reynolds, H.M., Golomb, D.H., Sckork, M.A., May 1977, "Anthropometry of Infants, Children, and Youths to Age 18 for Product Safety Design," UM-HSRI-77-17, Consumer Product Safety Commission, Bethesda, Maryland.

s. The properties created by regression equations are for a ***passive*** occupant or for an anthropomorphic dummy to be used in modeling the results of vehicle crash tests.

t. The occupants in an out of control vehicle are ***active*** occupants whose detailed measurements, musculature, joint properties and posture and therefore pre-impact location, can have a dramatic effect on the validity of predicted results and conclusions drawn thereof based on any occupant simulation.

u. In standard applications of occupant simulation models to interpolate and/or extrapolate test results, the kinematics of the occupant, as well as the occupant's initial position and orientation are known beforehand and the program inputs can be adjusted, as needed, for the specific application (***xxiv***)

v. "For real world accidents, actual observed kinematics are not available and there is thus no means to validate the accuracy of the input data used for the program" (**xxiv)**

w. "Even small deviations between input data and actual values may have significant effects on the reliability of the results" (***xxiv***)

x. "One cannot expect accurate simulations using generic force-deflection values" (***xxv***)

y. "Force-deflection values which have been established for a specific area of a specific vehicle have substantial variations depending on the location of the loading, the angle of loading, and the rate of loading" (**xxv)**

z. The extreme variability of force-deflection values is one of the most significant problems with using any other occupant simulation for accident reconstruction" (**xxv**)

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xxiv Declaration of John Fleck, February 25, 1992, Miller, et al, v VW, US District Court, Eastern District of California, No. CVF-90-312 REC

xxv James, Nordhagen, Warner, Allsop, Perl "Limitations of ATB/CVS as an Accident Reconstruction Tool", SAE Paper 971045

10. After over 40 years of research on occupant simulation there is no model in existence today which has been validated as a generally predictive model for detailed occupant kinematics in any type of real-world accidents.

11. Accident reconstruction programs and occupant simulation models are subject to limitations imposed by the mathematical idealizations and the simplifying assumptions inherent in any mathematical model of the physical world.

I declare under penalty of perjury pursuant to the laws of the State of North Carolina that the foregoing is true and correct and that this declaration was executed on November 26, 2002, at Cary, North Carolina.

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Brian G. McHenry

This Declaration has been reviewed and approved by

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Raymond R. McHenry