SWORN STATEMENT OF DENNIS P. CARLSON, JR.
February 20, 2004
Tucson, Arizona

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I N D E X

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APPEARANCES:

B.R. KASTER, ESQ.
125 N.E. First Avenue
Ocala, Florida 34470

BE IT REMEMBERED that pursuant to notice for taking sworn statements, the SWORN STATEMENT OF DENNIS P. CARLSON, JR., was taken upon oral examination at the Offices of Dennis P. Carlson, Jr., 1548-A South Euclid, in the City of Tucson, County of Pima, State of Arizona, before Kenneth W. Schippers, a Certified Court Reporter (CCR #50248), in and for the State of Arizona, on February 20, 2004, commencing at 8:30 a.m.

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DENNIS P. CARLSON, JR,
having first been duly sworn to tell the truth, the whole truth and nothing but the truth, testified as follows:

EXAMINATION

BY MR. KASTER:

Q State your name, please, sir.
A Dennis P. Carlson, Junior.
Q Mr. Carlson, what is your profession?
A I'm a tire consultant and professional engineer.
Q I wonder if you would give me the benefit of your educational background, please?
A I have a bachelor of mechanical engineering from the Georgia Institute of Technology and a master of science degree from the Georgia Institute of Technology.
Q Mr. Carlson, do you have a current CV?
A Yes, I do.
Q I'm going to attach that as an exhibit to this statement. We'll make that Exhibit 1.
(Deposition Exhibit No. 1 marked for identification.)
Q (By Mr. Kaster:) I wonder if you would

take a few minutes, Mr. Carlson, and tell us about your experience in the tire industry?

A For 10 and a half years I was an engineer that worked for Michelin Americas Research & Development Corporation. I had experience in testing and designing of tires while I was there.

Q Does that include steel belted radial tires?

A Yes, they were all steel belted radial tires.

Q Does it include light truck tires?

A Yes, it does.

Q Mr. Carlson, is there any substantial difference in the design components of a light truck steel belted radial tire and a passenger steel belted radial tire?

A No, especially in the LT series of light truck tires they are virtually the same as passenger tires, passenger radial tires. In fact, we use the same design techniques and many of the same testing procedures to develop light truck tires for the LT series light truck tires as the passenger group was using.

Q Well, I wonder, Mr. Carlson, if we might just take a minute and go through the basic components

of a modern steel belted radial tire starting from the tread and then going down through the tire.

A Well, the tread is the component of rubber material that touches the road. The tread usually has three components; one is the tread that touches the road. Underneath is what is called a base tread which has different properties to reduce the temperature and the rolling resistance of the tire, and then there's a third component usually called the under tread which has the purpose of increasing the rubber adhesion to the end of the steel cords. Above the steel belts there should be nylon cap plies.

After that you have two reinforcing layers of steel cords that are referred to as stabilizer plies or steel belts or breakers by the British. These are composed of little strands of wires that are twisted into cables. The cables are then laid parallel to each other to form a belt. They are surrounded by a type of rubber called skim stock rubber which has a property where it is able to stick to the steel belts.

There's usually two steel belts in the tread. They are lined at angles that are approximately 20 degrees plus or minus from the center line of the tire. The second belt is in the opposite

direction so this forms a grid of reinforcing material.

Between the edges of the steel belts you have a component called a wedge which separates the ends of the belts and reduces the stresses in that area. Under the belts are a component called the cushions which separate the end of the belts from the carcass ply and also help reduce stresses at the edges of the belts and provide a better profile of the belts so that the tire works better.

Under the cushion and the steel belts is the carcass plies. These are composed of polyester cords that are laid parallel to each other and are composed of polyester fibers in most tires and they run from one side of the tire all the way to the other under the beads. They form the body of the tire, and the beads, which are in the area that touches the rim of the wheel, are steel hoops that provide the base of the tire and reduce the effect of trying to blow the tire off the rim from the inflation pressure.

The innermost component is the inner liner which acts as the tube of a tubeless tire.

Q Mr. Carlson, you have a cutaway here in your office that's a cutaway of a modern steel belted tire. Does it depict most of these components that

you've just talked about?

A Yes, it does.

Q We'll attach that as Exhibit 2 to your statement.

(Deposition Exhibit No. 2 marked for identification.)

Q (By Mr. Kaster:) Mr. Carlson, one of the things you mentioned was an under tread?

A Yes.

Q What is the purpose of the under tread in a modern steel belted radial tire?

A Well, the under tread is a very special component because one of the weaknesses of the steel belted radial design is the fact that they use what is sometimes known as the brass sulfur method of achieving adhesion from the steel to the rubber. Steel naturally doesn't adhere to most rubbers, but the way that has been used in most steel belted radials to achieve this adhesion is that the steel is covered with brass and the skim stock rubber which surrounds the steel has an excess of sulfur and through a chemical process the sulfur allows the brass to adhere to the rubber so therefore you achieve adhesion, but the problem with this is that at the edges of the belts the manufacturing process cuts the

belts to form these edges and there is no brass coating.

The under tread is composed of a very special rubber that does have some adhesion to bare steel. It's a very expensive and very special rubber and cannot be used for the main process but it provides critical adhesion at the end of the belts.

Q Does it serve any purpose in the manufacturing process before the tire is vulcanized?

A Yes, it does. It also provides a level of adhesion in the green tire that prevents the belts and other products from shifting in the green state which is a state before it is cured and the tire is very delicate at this stage and the products can move either before it's put in the mold or in the mold and the under tread has the properties where it prevents some of this movement.

Q In other words, would it prevent, for example, the steel belts from shifting and becoming misaligned during handling before the tire is cured?

A Yes.

Q You've used the term green tire, Mr. Carlson. Explain to us what a green tire is.

A A green tire essentially is the tire before it is vulcanized. Vulcanization provides

adhesion between the rubber components, it provides adhesion between the steel components and the rubber components and it also changes the chemical properties of the rubber.

The vulcanization is a process where the rubber itself changes form drastically from a material that's more like modeling clay and has no permanent form to a tough elastic material that we see in the finished product known as the tire.

Q Mr. Carlson, I'm going to come back to the diagram that we've marked as Exhibit 2 and ask you some other questions about components of the tire in a moment, but first I would like to ask you to tell us what a tread belt detachment is?

A A tread belt detachment is where the tread and outer steel belt come off of the tire, they separate between the two steel belts and this belt and the tread come off while the vehicle is running.

Q Is that also commonly referred to by people in the industry as a tread belt separation?

A That's right.

Q Or a tread separation?

A Tread separation is one of the common names for it although technically it's not quite right but it is the term that is used most often to describe

this failure.

Q So if we say tread separation or tread belt separation or tread belt detachment, as far as our discussion today, that will be the same thing?

A Yes.

Q Is a tread belt detachment during service while a tire is in service, is that a dangerous event?

A Yes, it is.

Q And why is that, Mr. Carlson?

A Because it drastically affects handling and the stability of the vehicle. When you have a tread and outer belt detachment you have noise, vibration and drag put on the vehicle which causes an immediate steering effect and change in the vehicle handling. There is also a loss of traction in the tire, a loss of height and a loss of the friction capability of the tire on the road.

When you put a steering input into a vehicle and then you change the vehicle handling characteristics drastically all in a matter of a second or so, you have a serious potential hazard.

Q Is this the type of accident that we're familiar with as a result of the Firestone ATX and Wilderness AT tires on Explorers?

A Yes, that's exactly what we saw in the

Explorer Firestone ATX problem.

Q Mr. Carlson, during the course of your career as a failure analyst, have you had occasion to be involved in accident reconstruction or vehicle handling?

A Yes, I have.

Q Would you tell about that, please, sir?

A I worked for many years with SEA as an accident reconstructionist, a vehicle accident reconstructionist. I did approximately 600 vehicle accident reconstructions. I also, at my time at Michelin, being a tire designer I had to work with vehicle dynamic parameters as related to the tire.

For instance, one of the machines I ran in my first job at Michelin developed the handling parameters for GM's computer program. This involved the cornering coefficient, the aligning torque coefficient and the load sensitivity coefficients.

Then I was, when I was a tire designer, I was responsible for developing tires for Ford, Chrysler and GM, and in that we did many handling tests which are part of the criteria of when you develop an OE tire, an original equipment tire.

Q When you were affiliated with SAE, did you also do tire failure analysis there in addition to

accident reconstruction and vehicle handling dynamics?
A Yes, I did.
Q Mr. Carlson, how many years have you been involved in tire failure analysis or tire engineering?
A 26 years.
Q I want to return now to the tread belt detachment question. During the course of your career approximately how many tread belt detachment tires have you examined?
A More than 2,000. I started at Michelin because the tread separation was our primary concern, both at the time that I was a tire tester and the time that I was a tire designer. When I was a tire designer I was responsible for making construction and design changes to improve the durability of the tire in relation to separations. This involved, for instance, changing the wedge size and testing the tires to separation failure in our very special methods that we had to develop failures in these tires.
And then for five years at the test track I ran the tests that developed separation failures using scientific procedures.
Q Scientific procedures?
A Yes, scientific procedures were used to

develop these failures in a controlled and reproducible way. And this was the primary test of adhesion for Michelin Tire Corporation.
Q Mr. Carlson, is tread belt detachment one of the most common modes of failure of steel belted radial tires?
A Yes, it is.
Q Has it been since they've gone into production in the 1960's?
A Yes, ever since the first one in 1948.
Q Actually '48?
A Yes.
Q What causes a steel belted radial tire to suffer tread belt detachment during normal service?
A Improper design or improper manufacture.
Q Should a steel belted radial tire that's properly designed and properly manufactured experience tread belt separation during the normal course of service during its useful life if there's not a design or manufacturing defect?
A No, they should not.
Q When you examine a steel belted radial tire that has experienced a tread belt detachment what is the procedure that you follow?
A The first part of the procedure is I use

a visual and tactile examination of the tire and then I note any unusual factors that I see in the tire and then I take that information and test it by considering the possible causes of this failure and see which one is the most appropriate.
Q Mr. Carlson, if a consumer were to run their tire under inflated, would that cause a tread belt separation in properly designed and constructed steel belted radial tire?
A No, it would not.
Q Would the penetration of a nail or some penetrating object cause a tread belt separation in a properly designed and constructed steel belted radial tire?
A No, it would not.
Q If a consumer experienced a penetration of some kind and had it repaired with a plug, would that cause tread belt separation in a properly designed and constructed steel belted radial tire?
A No, they should not.
Q If a consumer were to hit a pothole or some other object were to have an impact on their tire, should that cause a tread belt detachment in a properly designed and constructed steel belted radial tire?

A No.
Q Can impact damage cause tire failure?
A Yes, it can.
Q What type of failure is caused by impact damage?
A Generally you have a very localized failure. They usually run into two or three types of localized failure but you don't get a complete separation unless the tire is defective in some way.
Q Within a reasonable degree of engineering probability is there anything that a consumer can do to a tire to cause the tire to have a tread belt separation?
A No. In the real world with consumers it is virtually impossible to develop a tread and outer belt separation in a properly designed and manufactured tire.
Q Now if a tire is worn past its normal useful life so that the cords are exposed to the atmosphere and moisture could get into the body of the tire, can that cause or contribute to tread belt separation?
A Yes, it can.
Q And when you conduct a visual and tactile examination of the tire, is that readily discernible

to you?
A Oh, yes, very easy. It's very easy to see.
Q When you conduct your visual and tactile examination, what are you looking for in order to determine whether there's a design or manufacturing defect?
A In the area of manufacturing defects we look for characteristics of the type of loss of adhesion in the tire. We look for the polishing; the shape and type and area of the polishing. We look for pattern marks which indicate bad adhesion from the manufacturing process in the rubber to rubber layers. We look for bare cables that indicate a loss of adhesion from the steel to the rubber.
We look for manufacturing defects that cause an increase in the stress such as misaligned belts and a lack of wedging material.
Q Mr. Carlson, you gave me some examples of some of the things that you are looking for in order to determine whether there's a manufacturing defect?
A Yes.
Q Is that an all-inclusive list?
A No, it's not.
Q Is there actual, physical evidence on the

tire of the things that you have just talked about?
A Yes, there are and there's many others that we could talk about, also.
Q But if you were to find, for example, liner pattern marks, that would be something that another engineer could look at and also see as physical evidence on the tire?
A That's right.
Q And the same thing with misalignment of belts, if you found that the steel belts were misaligned then another engineer who came after you would look at it and see the same misalignment?
A That's right.
Q Bare steel cord?
A Yes.
Q I'm going to stop at bare steel cord for just a moment. You've told us that the steel cord in the modern steel belted radial tires are steel end cables that are coated with a layer of brass if I understood you correctly?
A That's right.
Q What's the purpose of the brass layer?
A To achieve adhesion to the skim stock rubber.
Q Why is that important?

A Well, it has to stick together. Every part of the tire has to stick to every other part of the tire and that's achieved through different mechanisms. Most of the rubber components stick to each other in the vulcanization process by a process called cross linking which is similar to the vulcanization but the steel has to adhere to the rubber and that's not a very easy thing to do so the steel is coated with brass and there's extra sulfur put in the surrounding rubber.
The sulfur forms a compound with the brass component which are copper and zinc. It forms copper sulfide and brass sulfide so therefore you achieve adhesion from the steel to the rubber by putting another element in between the two.
Q Mr. Carlson, is the rubber that's used to adhere to the steel cord what's commonly referred to as skim stock?
A Yes.
Q Is that an important component in steel belted radial tires?
A It's one of two most important compounds in a steel belted radial tire. The other being an inner liner.
(Deposition Exhibit No. 3 marked for

identification.)
Q (By Mr. Kaster:) Mr. Carlson, let me hand you what I've marked as Exhibit 3 and ask you if that's the type of depiction that you are familiar with?
A Yes, this is a picture that shows steel cord similar to what is being used in a steel belted radial after a pull test which is a type of adhesion test, a standard adhesion test and you essentially cure a block of rubber with steel cords in it and you pull them and one of the measurements that you do is the amount of coverage. This graph shows five stages of coverage from a hundred percent to zero percent.
Q Is this the type of test that's done on a continual basis by all steel belted radial tire manufacturers?
A It's done on nearly ever batch of skim stock ever produced.
Q Is it a quality control procedure?
A Yes.
Q Is it a necessary quality control measure?
A Very much so.
Q And what level of coverage is necessary in order for a batch of belt wire cord wire to be

released into production?
A Generally very close to a hundred percent of coverage.
Q If the pull test resulted in coverage of say zero to 50 percent, should that wire be used?
A No.
Q If it resulted in 50 percent of coverage, would you recommend that the wire be used?
A Probably not.
Q And why is it so important to have this bond between the skim coat and the steel cords in a steel belted radial tire?
A To prevent failures. It's one of the most difficult processes of making steel belted radials and it has a direct relationship to the life of the tire, of the fatigue life of the tire.
Q Mr. Carlson, we've kind of gotten off on a tangent there, and I apologize, you were explaining to me what you do in your failure analysis of a tire that's suffered a tread belt detachment and you've given me some of the manufacturing defects that you look for that's manifested in physical evidence. What else do you do?
A We look carefully at the material to see if there's evidence of advanced aging. The brittle

element of skim stock is an indicator that the skim stock does not have enough anti-degradants in the rubber. Another thing we look at, but it's hard to pigeonhole whether it's a design or manufacturing defect, is the inner liner. The inner liner can be made too thin in the area of the shoulder and we look for some of the characteristic signs of that.
Q Do you find physical evidence if there's a thin inner liner?
A Yes, we can.
Q What are some examples of that?
A We can see cable shadowings which means that you can see the carcass ply cables, the impressions of the carcass ply through the inner liner. This is a sign of an inner liner that's too thin.
Q Do you also, during your examination, look for design defects in a tire that's suffered tread belt detachment?
A Yes, we do.
Q Tell us about that, please, sir.
A Well, there are four classic design elements that we look for that have been developed as countermeasures to steel belted radial separations. One of the first is what is called a belt offset where

the bottom belt is made wider than the top belt so that the stress is not concentrated at the edge of two belts but is spread over this distance that you separate the edge of the belts.
A common difference in this width at the edge is a quarter inch on each side and we look for that because many belts are laid off center or they may be serpentine which changes this important countermeasure.
Q Mr. Carlson, that sounds to me like a manufacturing defect rather than a design defect?
A It generally is a manufacturing defect.
Q What about the width of the belts themselves, is that design or manufacturing?
A That is generally a design defect.
Q I'm sorry, I interrupted you. What other things do you look for as far as design defects that manifest themselves in tread belt detachment?
A The second countermeasure that was developed was the use of a tread cushion. This is a piece of rubber that has special properties that's put under both belts, at the edge between the belts and the carcass plies and this has the effect of flattening the belt package out which reduces some of the stress at the ends of the belts, and we look at

the design and the manufacture of the cushion. Frequently we'll see that the separation begins in the cushion which indicates bad adhesion in the cushion.
The third is the presence of a wedge which is a type of rubber which is put between the steel belts at the edge. This separates the belts and reduces the stress there.
Q You mentioned twice now the stress at the belt edge. Can you explain to us what you're talking about?
A The edges of the belts have a very high stress level because of the stress concentration at that point because there is a natural hinge point at this where you go from the stiff belt, steel belt of the tread, to the more flexible sidewall material which is composed of strings of polyester, and when you go from that stiff to the flexible area, you have a natural stress concentration at the edge of the belts.
If you do not have some of the other countermeasures such as under treads and such, you also have a problem because of the cut belts, you don't have adhesion at the edge of the belts.
Q Because there's no brass on the ends?
A Because there's no brass on the ends to

have that adhesion. That's why the under tread is so important because of the special rubber that does have some adhesion. Otherwise, you would have separations at the end of each little wire in a brand new tire.

Q Okay. We've talked about the inner liner, cushions and belt edge wedges. Are there other design anomalies that you look for in a tire that's suffered tread belt separation during your visual and tactile examination?

A Yes, one of the other countermeasures that has been developed approximately 30 years ago was the nylon, zero degree nylon cap ply.

Q Is that depicted on your cutaway, your color cutaway that we've made Exhibit 2?

A Yes.

Q What is the purpose of the nylon cap ply, Mr. Carlson?

A It is used to reduce the stress at the edge and reduce tread and outer belt separations.

Q Has that been documented in literature over the course of the last several decades?

A Yes, it has.

Q Has that been proven in actual field experience with actual steel belt radial tires?

A Yes, nearly every tire manufacturer I've

investigated they have reduces separations by the use of nylon cap plies.

Q Would you give us an example of the reduction or elimination of separations through the use of nylon cap plies?

A Yes, the most common of the recent examples is Goodyear. They ran into a problem with their light truck tires and did an extensive investigation of their manufacturing design process but they found that the only thing they were sure of was that nylon cap plies would stop the problem of separations in their tires.

Q Did it?

A Yes, it did.

Q And have you seen the documentation from Goodyear and the sworn testimony that verifies that?

A Yes, I have been through many of their documents, and not only was there testing verification but there was verification in the results in the real world. There were virtually no separations after they put the nylon cap plies on these tires, whereas they had a large separation problem before they put the nylon cap plies on.

Q Mr. Carlson, during your visual and tactile examination of a tire that's suffered a tread

belt detachment, do you use any type of illumination or magnification?

A Yes, I do.

Q And when you complete your examination, are you usually able to determine the cause or causes of the tread belt detachment failure?

A Most of the time, yes.

Q Do you do additional tests or analysis to support your initial conclusions or opinions?

A Yes, I do.

Q Okay. Would you tell us about some of the things you do to provide you with additional information in support of your opinions or conclusions or in order to help you reach opinions or conclusions?

A Generally we use x-rays. X-rays have a great value in depicting the joints that are put in the steel belts, and many times you cannot find these in the failed tire but they will lead to where there is an abnormality in the steel belt manufacture that contributes to the start of the separation. They also give evidence of the condition of the tire's manufacture in the belt area.

Q Mr. Carlson, do you do what's known as cut tire analysis?

A Yes, we do.

Q Tell us what that is first and then I want to ask you some questions about that.

A Cut tire analysis is where you take an exemplar or companion tire and cut it radially so that you have one or two inches of the tire and can see the internal components of the tire.

Q What does that tell you concerning the design of the tire or design defect in the tire?

A It tells you what the design of the tire is to a large extent. It shows you not only the design but manufacturing variations of the tire.

Q Can you measure the components of the tire such as the thickness of the skim stock or thickness of the various components that are critical in determining whether the tire is appropriately designed?

A Yes, typically when I look at a tire I measure the wedge thickness, the wedge width, the offsets and the inner liner thickness.

Q Have you done cut tire analysis on all of the tire manufacturers that produce tires for use in this country over the course of your career?

A Yes, we have more than 400 that we've looked at recently.

Q Does that include Firestone, Cooper,

Goodyear, General and others?
A Yes, and we're building up a library of foreign tires, also.
Q Are you aware that the tire industry routinely does cut tire analysis of their own tires and their competitor's tires?
A Yes, I did this when I was at Michelin and I reviewed some results from manufacturers and they use cut tire analysis every day in every plant in the United States and in the world.
Q Why would they do a cut tire analysis of tires in the plant?
A Cut tire analysis is the main tool to determine whether a tire meets the specs that the tire manufacturer has set for their tires.
Q Obviously you can only do a random sampling to do a cut tire analysis because it destroys the tire?
A That's right.
Q If I understand what you're telling us, every tire manufacturer on a daily basis does cut tire analysis of samples of tires they have produced to make sure that their manufacturing process is appropriate and that they have not made any mistakes in the manufacturing process that would affect the

durability of the tire?
A That's right. Typically when a manufacturer starts a run of a certain type of tire, they will set up a machine, they will build a few tires and the first thing they do, they'll cut them, they'll send them to a department that will analyze these and compare them to the spec. If they receive the okay, then they will start production on those machines using that setup.
Q Is cut tire analysis performed by any independent entities that you are aware of?
A Yes, it is.
Q Tell me about that, please, sir.
A There is at least one company who publishes cut tire analysis regularly and sells the service to the tire manufacturers.
Q Mr. Carlson, are you familiar with the entity or entities that conduct cut tire analysis?
A Yes.
Q And who would that include?
A Smithers is the most common practitioner of this. They make reports and sell them to the tire companies.
Q And what does that company provide in the way of information as a result of the cut tire

analysis?
A It provides them the physical dimensions of the components of the tire. It provides them with some rubber analysis done with a type of analysis you can do with cured tires. It provides photographs of the tread and the wire constructions.
Q Are you aware of whether tire manufacturers reverse engineer their competitors' products.
A Yes.
Q Have you ever done reverse engineering on a steel belted radial tire?
A Yes, I have.
Q Does that include the cut tire analysis you're talking about?
A Yes.
Q Have you done any reverse engineering to determine the chemical composition of any steel belted radial tire?
A Yes, I have.
Q And how did you accomplish that?
A I have obtained rubber samples in the green state and they are being chemically analyzed.
Q And you mentioned that Smithers does a chemical analysis of the cut tires. Those would be

cut tires?
A Yes.
Q Mr. Carlson, when you are analyzing a tire that's suffered a tread belt detachment after you have completed your initial visual and tactile examination and whatever x-ray testing or other testing that you believe is appropriate, do you reach a preliminary opinion concerning the cause and mode of failure?
A Generally, yes.
Q After you have reached that opinion, do you consider the cut tire analysis for the tire manufacturer that you're undertaking that manufacture the tire?
A Yes.
Q Do you consider prior similar failures by the same manufacturer in the cases that you have analyzed tread belt detachments?
A Yes, I do.
Q Do you review manufacturing records from the manufacturer who manufactured the tire?
A When I can, I do.
Q And among the records that you would want to review, what do those include?
A Manufacturing records such as the

specifications. This includes the green tire and the cured tire specs.

Q Why do you want to look at both the green tire and cured tire specs?

A The green tire and cured tire specs are both necessary to determine the design of the tire and the manufacturing technique. For instance, the green tire spec gives you the components that are put in the tire, the order in which they are put in and certain features about how the manufacturing process is performed.

The cured tire spec tells you the sizes of the components as they are designed, as they were designed to be.

Q Does the gauge or thickness of components change from the green tire state to the cured tire state?

A Yes, for instance, the inner liner which is one of the most important pieces of rubber in the tire, frequently in the as-built condition is half the thickness of the green configuration.

Q Is one able to determine whether the design gauge of a tire is appropriate by just the green tire specs?

A No, it's not.

Q Are there other records that you review for the manufacturer that relate to your opinions concerning the cause of failure?

A Yes. One is the developmental testing results and the surveillance testing results that are performed on all tires. When I mean design you look at the original design testing to see the actual durability of the tire related to other tires in the plant or competitors' tires.

Q What type of durability testing is routinely conducted by tire manufacturers?

A One is frequently called the ATE test, Accelerated Tire Endurance test. This is a test where tire is run near the design maximums for a long period of time, then cut tire analysis or some other analysis like holography or shearography is done on the tires to see how far the separations have progressed during this more or less real world test.

Q Have you reviewed tire durability testing including holographic testing and cut tire analysis of tires that have been tested in durability testing by manufacturers?

A Yes, I have. In fact, I also ran this test for four and a half years at Michelin.

Q Is this important data to review in order

to determine whether a tire is likely to suffer tread belt detachment during the course of its useful life?

A Yes, it is very important. When you design something you start out deciding what the life of your component is or whatever you're designing but you have to test it to see if you've achieved those goals.

Q In addition to reviewing the green tire specifications and the cured tire specifications and the durability testing and the holographic and cut tire analysis of durability testing, are there other manufacturing records that you routinely review that you find supports your opinions or conclusions?

A Yes, as I mentioned, the quality control documents involve a large range of documents. One of these is in-plant types of reports. These can be anything from the machine capability studies that are done on tires by the quality control department to downgrade reports and various types of nonconformity reports. The quality control department should catch any nonconformities in the manufacturing or design process in the manufacturing and they write reports on this and these frequently relate to the types of failures that we see in the field.

Another important part of the quality

control process is the adjustment records. There are generally three types of reports that are produced by companies about their tire's performance in the field. One is adjustment records which involve tires that are brought back to the dealers that have some complaint by their owner. This type of data is used by the tire companies and is compiled in computers and reviewed by their designers and their manufacturing people to see how their products perform in the field.

Q Okay. I'm going to come back to that in just a minute but let me ask you, are there any other manufacturing records that you routinely do in support of your opinions or conclusions?

A Yes.

Q What would that be?

A There's cure charts and curing records.

Q Why are they important?

A Well, curing records, the vulcanization is one of the major parts of the production of a tire. It has produced, besides the Firestone 500 and the Firestone ATX and Wilderness AT recalls, it has produced perhaps more recalls than any other reason.

Q Is this something that tire designers review when they are trying to determine why they have a problem with a tire in the field that suffered tread

belt detachment?
A Yes, it is one of the first things they look at.
Q You've mentioned adjustment reports. What is the source of the data for adjustment records?
A The consumer.
Q What do you mean by that?
A The consumer, when he has a problem with the tire, takes it back to his dealer and tells him about the problem. This generates an adjustment report that works its way into the computer at the tire company.
Q And if this is a consumer complaint, is this what would be considered in tire engineering or tire manufacturing to be a trade secret?
A No.
Q Do tire manufacturers attempt to prevent people from obtaining the adjustment data?
A Yes.
Q If people do obtain the adjustment data, does it give them an indication of a particular tire line's durability in service?
A Yes.
Q In the ATX and Wilderness recall, for example, did adjustment data play a significant part

in evaluating the problem?
A No, it did not.
Q Should it have?
A It should have.
Q Have you reviewed that adjustment data?
A Yes, I have.
Q And does it indicate that there was problem with the ATX and Wilderness?
A I believe it does.
Q For how long a period of time does that adjustment data cover?
A Almost 10 years.
Q Is that an appropriate period of time to analyze a tire's performance in the field?
A Yes, it is.
Q Why not use just one year or two years?
A That doesn't tell you very much about the tire. The types of failure that you have in a tread and outer belt separation is what is generally called a fatigue failure and it usually does not start until after one year of service.
Q Well, if you pick out a year after a tire has gone into a service, say five years down the line and just look at one or two years, does that give you the appropriate data to be able to analyze the trends

as far as the failure of the tire?
A No.
Q Why not?
A Well, because these failures start at one year but they peak at about three years, three years out in the service but tires are used for a lot longer period than that and you have significant failures after four or five years.
Q Can you make any determination looking at, say, for example, a 10 year window of tread separation categories of the effects of changes in the design of the tire during that period of time?
A Well, any changes would have to be followed for a number of years after that.
Q Mr. Carlson, when one looks at adjustment data to determine the extent of tread belt separation failures or tread belt detachments, how many categories does one look at?
A Generally seven to 10. Every tire company has perhaps 200 different categories that they look at among adjustment. We have found that seven to 10 of these categories reflect tread or outer belt separations either that have occurred or are about to occur.
Q I recall having seen data on adjustment

reports that reflect tread separations and ride disturbance, for example. Why would you include ride disturbance?
A Ride disturbance can be a separation in progress. They can be caused by a structural failure in the tire that would indicate that the tire is separating.
Q When one looks at adjustment data, do they limit that to just one plant where the tire is produced?
A Generally not. They look at all tires that have the same skim stock to start with, they generally look at everything company-wide because there's so much uniformity between the manufacturer of these tires across even a large company.
Q Is there ever comparison made between tire lines in order to determine whether one line has more problems than another?
A There are determinations sometimes, but generally they just look at the whole company over a long period of time.
Q In the adjustment data analysis that's provided to manufacturing plants do they break that down to tire sizes or tire line?
A Generally not. Some people may make a

special study but when manufacturers and designers look at the performance of their tires, they generally look at the whole plant or the whole company.

Q And have you seen data from various manufacturers that reflects in the adjustment data all tires produced at any given plant during the period of time that they are analyzing the data?

A Yes. One of the most common types of analysis is they compare the different plants. This has an effect because it shows first the performance of one plant relative to another.

Q Mr. Carlson, is there a difference between what's known as adjustment data and claims data?

A Yes.

Q What is claims data?

A Claims data, again, comes from the consumer but the consumer has suffered a tire failure and he has suffered damage generally and he wants to get paid for his fender or his vehicle that's been damaged.

Q Are most of those claims based on tread belt detachments?

A Yes, they are.

Q Is it important to look at that data in

order to get an accurate picture of the extent of a tread belt detachment problem within a company?

A Yes.

Q And do you also want to look at those tires?

A Yes.

Q Why?

A Well, these tires are failed tires and I would like to analyze them to see the effects of the manufacturing and design abnormalities that would be seen in this tire that caused this failure.

Q Mr. Carlson, during the course of your career as a tire failure analyst have you visited various tire manufacturing facilities in this country?

A Yes, I have.

Q Why?

A This was to assess their manufacturing processes and the quality of their controls on the manufacturing process.

Q And what did you learn?

A I learned that there were some very serious problems at these plants.

Q Have you, during the course of your career, reviewed sworn testimony of plant employees?

A Yes, I have.

Q And was that of any assistance to you in evaluating the quality control of various manufacturers?

A Yes, it was. It was very important.

Q Why is that, sir?

A Because it showed many of the things that go on day to day at a tire plant that can affect the quality of the tire as related to tread and outer belt separations.

Q Have you found that testimony of plant workers to be consistent with the manufacturing anomalies that you have found in tires that have suffered tread belt detachment?

A Yes.

Q Has their testimony strongly supported your opinions on manufacturing defects?

A That's right. They have, yes.

Q Has that included employees from Firestone?

A Yes.

Q Cooper?

A Yes.

Q Uniroyal?

A Yes.

Q Have you reviewed prior art in reference

to tread belt detachment or countermeasures for tread belt detachment?

A Yes, I have.

Q Can you tell me some of the things that it includes?

A We looked at the records that had been presented in the patent literature. There have been some technical papers that have been written that we've studied, and then we have the cut tire analysis on old tires that we've looked at, and we reviewed the testimony of people from the tire plants and other people in the industry concerning the development of tires, and we've also reviewed some of the trade publications that have been published over the years. We have some trade publications going back 30 years.

Q Have you reviewed scientific and engineering literature in the field of tire design and tread belt detachment?

A Yes.

Q Have you reviewed independent testing that's been conducted in the area of tread belt detachments in order to make determinations regarding tread belt detachments?

A Yes.

Q Has the literature that you have reviewed, the prior art and the testing, supported opinions that you have concerning design defects in steel belted radial tires?
A Yes.
Q Have you, yourself, conducted analysis of steel belted radial tires and written on the subject?
A Yes.
Q And on what particular subject have you written, Mr. Carlson?
A Pressure grooves and analysis of data that has been produced by other people.
Q And is a copy of that paper available to us?
A Yes.
Q We'll attach that as Exhibit 4.
(Deposition Exhibit No. 4 marked for identification.)
Q (By Mr. Kaster:) When you receive tire manufacturers' data concerning the testing they have conducted, their manufacturing process, their adjustment records and claims data, are you permitted to disclose that in other cases?
A No.
Q Why not?

A There are agreements that are signed that restrict the use of that material, protective orders.
Q Mr. Carlson, is the data that you have referred to, the test data, durability testing, manufacturing data that's available to manufacturers, is all of that data made available to you when you're evaluating a tread belt detachment of a manufacturer's tire?
A No, it's not.
Q Why wouldn't they show you the data that they have available if you've agreed to a protective order?
A The only thing I can tell you is that I found that when I receive the manufacturing records that we have been referring to they always support my opinions. The manufacturing records, curing specs, test data and adjustment record documents document the problems that occur in the manufacturing or design process which cause or contribute to the manufacturing defects or design defect in the tire that result in tread belt separations.
Q And when you have been given the data that's available to the manufacturer concerning the failed tire, has that strongly supported your opinions and conclusions?

A Yes, it has.
Q Do the manufacturers usually attack you or your credentials in litigation to try to have your opinions limited or struck?
A Yes.
Q Are they usually successful?
A Rarely are they successful.
Q When you have been provided with the manufacturing records and the data that we've talked about, the curing data, test data, quality control data, adjustment records and such, in your experience does that provide you support for your opinions which makes it more difficult for the manufacturer to limit your opinions or testimony?
A Yes, it does.
Q Does it level the playing field, Mr. Carlson?
A Yes.
Q Is there any other way that you can get this information other than from the manufacturer?
A No.
Q Mr. Carlson, I want to go back to something you mentioned. You said monthly adjustment reports. What are monthly adjustment reports?
A There are adjustment records that are

delivered to the manufacturers monthly in some plants. Sometimes they are quarterly but there will be a report that's generated every month having to do with the performance of the tire in the field.
Q And based on your knowledge gained from the sworn testimony of manufacturers' representatives, do they rely on these monthly reports in the manufacturing process in order to try and improve the quality of the tire?
A Yes. It provides an early warning in some cases to the manufacturing people and the design people.
Q Is this one of the pieces of data that would be important to you in your analysis of a particular tire plant's or manufacturer's steel belted radial tire tread belt separation failures?
A Yes.
Q The technique that you use, Mr. Carlson, in your visual and tactile examination of the failed tire that's experienced tread belt detachment, is that the same procedure and technique that's followed by experts in the field who are employed on behalf of manufacturers as well as independent experts such as yourself?
A Yes.

Q Is the methodology that you follow the same methodology that you used at Michelin and the same methodology used by tire failure analysts generally?
A Yes.
Q I would like you to now, Mr. Carlson, if you would, tell us about your experience in analyzing Firestone tires.
A Well, I was the principal tire expert for the group of attorneys general from the 50 States who analyzed the Firestone ATX and Wilderness AT separation problem, and I assisted the attorneys general in their investigation of this problem over a period of almost two years.
Q Mr. Carlson, did that include the attorney general for every state?
A Yes, it did.
Q Florida, Texas, California, Arizona, Utah?
A All 50 states.
Q Did you actually deal directly with every attorney general?
A No, there was a core group that handled the investigation from four or five states and I worked directly with them.

Q Did all of the attorney general's to your knowledge rely on your expertise in trying to determine the cause for the tread belt separation or tread belt detach. Of the Firestone tires?
A Yes.
Q And were you privy to trade secret documents and protected documents in your role as expert for the attorneys general?
A Yes.
Q Have you had other experience in analyzing Firestone tires that have suffered tread belt detachments?
A Yes, I have.
Q Would you tell me briefly about that, please, sir?
A I have been working with -- I had two of the first of the ATX cases, two of the first that achieved national prominence.
Q And have you seen Firestone tread belt detachment cases since then for other tires other than, including ATX Wilderness, but other Firestone tires?
A Yes, I have.
Q Have you found a common failure mode?
A Yes, I have.

Q Can you tell me, Mr. Carlson, whether you have learned the skim stock formula for Firestone tires, steel belted radial tires?
A Yes, I have.
Q And have you seen specifications for the inner liner of Firestone tires?
A Yes, I have.
Q Are you aware of the wire configuration of the belt wires for Firestone tires?
A Yes.
Q And can you tell me how widely used among Firestone steel belted radial tires is the skim stock that you have seen?
A In the whole decade of the 90's this skim stock was used in virtually every standard type of passenger and light truck radial tire.
Q Light truck?
A I believe the light truck had the same skim stock.
Q What about the inner liner?
A The inner liner material was the same in virtually all of these tires. It was the same material but it was used under two designations, but it's the same material.
Q Did that include both passenger and light

truck?
A Yes.
Q What about the cord wire?
A The cord wire was used in virtually all of their passenger radials and some light truck tires.
Q And their wedge specification?
A Wedge specification was the same in all of those, all the passenger tires. It was changed twice in the decade of the 90's and that change was effected in all passenger radials.
Q Mr. Carlson, if there is a failure of a Firestone steel belted radial tire by tread belt detachment, is that limited to one line of tires?
A No, it's not.
Q One size of tires?
A No.
Q Does it matter what the tread pattern is?
A No, it doesn't.
Q Does it matter what the tread width is?
A No.
Q Does it matter what the load range is?
A No.
Q Does it matter what the speed rating is?
A No.
Q What are the common elements, other than

skim stock, inner liner, wedge compound and steel cord?
A The other common elements are the manufacturing techniques, the machinery, many of the compounds and the testing procedures, the manufacturing procedures and the manufacturing quality control, and the basic construction.
Q As depicted in Exhibit 2 with the exception of the nylon overlays?
A That's right.
Q Mr. Carlson, have you been provided with data on when Firestone began using the under tread and the testing of the effects of under tread on preventing tread belt separation?
A No.
Q Would you like to see that?
A Yes, I would.
Q Mr. Carlson, if a modern steel belted radial tire does not include the countermeasures of a nylon overlay, appropriate wedge, appropriate inner liner thickness and composition, appropriate skim stock chemical composition and thickness and an under tread, is the tire defective in design?
A Yes.
Q Can the defective design lead to tread

belt detachment?
A It leads to premature tread belt separations.
Q How long have these countermeasures, I think I left out the cushion, and I apologize, Mr. Carlson, is cushion one of the countermeasures that should have been included?
A Yes.
Q How long have these countermeasures been available in the marketplace?
A At least 30 years.
Q Mr. Carlson, are you familiar in the context of ATX Wilderness testing of what's known as the Southwest Survey?
A Yes, I am.
Q What is that, sir?
A It was a survey that was done in the southwest part of the United States by Firestone to report to Ford about the durability of their tires in the hotter climates.
Q And have you become aware recently that they actually did cross-sections of some of those tires?
A Yes.
Q Would you like to see those?

A Yes, I would.
Q Why are they important?
A Because I would like to see not only the progress of the failure but the manufacturing variations that existed in those tires and the design variations that occur.
Q Mr. Carlson, is there any way now to evaluate that evidence or reproduce that evidence if it's been destroyed?
A No.
Q Is it critical evidence in the context of tread belt detachment of ATX or Wilderness tires?
A I believe it is most critical.
Q Does it relate to tread belt detachment of other tires other than AT?
A Yes, they all have the same skim stock and construction details and design details.
Q Mr. Carlson, how much experience do you have evaluating Cooper tread belt detachments?
A A lot.
Q And how would you characterize their manufacturing process as compared to other manufacturers you're aware of?
A Very low level of care and capability in their manufacturing process and control.

Q What about the design of their tires, how does it compare to other tires, say Goodyear, Michelin, Continental, Pirelli?
A They are very far behind. They don't use some appropriate countermeasures in their tires.
Q Such as?
A Such as wedges, under treads and nylon cap plies.
(The sworn statement was then adjourned at 10:00 a.m.)

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STATE OF ARIZONA)
) ss.
COUNTY OF PIMA)

BE IT KNOWN that I, Kenneth W. Schippers, took the foregoing sworn statement pursuant to notice at the time and place stated in the caption hereto; that I was then and there a Certified Court Reporter (CCR #50248) in and for County of Pima, State of Arizona; that by virtue thereof, I was authorized to administer an oath; that the witness, DENNIS P. CARLSON, JR, before testifying was duly sworn to testify the truth, the whole truth and nothing but the truth; that the testimony of said witness was reduced to writing under my direction and the foregoing pages contain a full, true and correct transcription of my notes of said sworn statement.

I FURTHER CERTIFY that I am not of counsel nor attorney for either or any of the parties to said action or otherwise interested in the event thereof, and that I am not related to either or any of the parties to said cause.

IN WITNESS WHEREOF, I have hereunto subscribed my name this 3rd day of March, 2004.

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