1001 Pennsylvania Avenue, NW, Washington, DC 20004-2595 • p202 624-2500 • f202 628-5116

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September 3, 2003

BY HAND & REGULAR MAIL

Ms. Kathleen C. DeMeter, Director
Mr. Bruce York
National Highway Traffic Safety Administration
Office of Defects Investigation
400 Seventh Street, S.W.
Washington, D.C. 20590

Re: EA02-025: IR Response of E. I. du Pont de Nemours and Company

Dear Ms. DeMeter and Mr. York:

E. I. du Pont de Nemours and Company ("DuPont") respectfully submits this response to your letter inquiry to DuPont of June 3, 2003 regarding EA02-025. This letter supplements our meeting with Messrs. Quandt and York in your offices on July 31, 2003, at which DuPont and NHTSA began what we regard (and hope that you regard) as a productive exchange on the issues before NHTSA. We sincerely appreciate the extension of time you and Mr. Quandt have granted DuPont for providing this response.

This narrative response adopts the form your letter specifies, with each numbered inquiry repeated verbatim (in bold), followed immediately by requested information. The information for this response was gathered principally in late 1999 and 2000 in connection with related litigation, both from review of DuPont business files and through interviews with DuPont past and present personnel, principally those located at DuPont High Performance Films in Circleville, Ohio. Further responsive information was obtained from documents provided by Ford Motor Company (hereinafter "Ford") and Texas Instruments, Inc. (hereinafter "Texas Instruments"), and depositions of Ford and Texas Instruments personnel, in the course of related litigation, and in interviews of DuPont personnel and review of DuPont files since receiving NHTSA's June 3 inquiry.

Enclosed as requested is a version of this narrative response on disk in Microsoft Word 2000 compatible format, entitled "IR Response."

Accompanying this letter response are documents responsive to NHTSA's inquiry. The documents are number-stamped for ease of reference. Throughout we use the document designation "DD/NHTSA No. _____," with the first blank containing the numbered inquiry to which the document relates and the second blank containing the document's given number.

When referring to documents, this narrative references these document designations. Certain documents submitted were previously produced by Ford, Texas Instruments and/or DuPont in related litigation and, in addition to the DD/NHTSA number, bear Bates numbers from that litigation (*i.e.*, Ford applied numbers such as 3713 2054; Texas Instruments applied numbers such as TI-001468; and DuPont applied numbers such as DUP 000026).

As DuPont previously informed NHTSA, DuPont has in its possession files related to the related litigation. To only a limited extent are these materials called for by the itemized requests contained in NHTSA's June 3 letter. Nonetheless, we have previously stated, and reiterate here, that DuPont is pleased to make available to NHTSA its litigation files (pleadings, deposition transcripts, and other non-privileged litigation materials) at a time and location of NHTSA's choosing should that prove desirable.

Certain limited materials provided today to NHTSA are confidential to DuPont. Specifically, DuPont documents DD/NHTSA No. 6 00001 through 00132 are confidential business documents and are so designated here pursuant to 49 CFR §§ 512.5 and 512.4 and 5 U.S.C § 552(b)(4). DuPont respectfully requests that these limited materials be withheld from public disclosure. Pursuant to NHTSA procedure, each has clearly been marked confidential, and confidential treatment is requested for the entire page of each such document. Pursuant to 49 CFR § 512.4(b)(2), DuPont respectfully requests a brief extension of time in which to submit the supporting information necessary to support this claim of confidentiality in accordance with 49 CFR § 512.4(b)(3) and (e).

DuPont's guiding objective in providing this response has been to be forthcoming and cooperative in accurately and fully addressing NHTSA's inquiry. We emphasized this objective in DuPont's meeting with NHTSA on July 31, and invited Messrs. Quandt and York to contact DuPont if and when we can be of assistance. We reiterate that invitation. If this narrative and document response is found lacking in any respect, please contact us and we will endeavor to address perceived gaps.

One final threshold note: throughout this response DuPont has understood NHTSA to be seeking information regarding DuPont products as they appear in the subject vehicle and subject switch environments as defined in NHTSA's June 3 letter. As discussed previously with NHTSA, the DuPont products in question and variations of these products are found in many applications, including many outside the automotive environment. NHTSA has made clear to DuPont that it is not seeking from DuPont such information beyond the subject vehicle and subject switch applications. DuPont's responses herein proceed based on that understanding.

1. **Describe DuPont's role and interaction with Ford and Texas Instruments in the design, material selection, specification, validation, and failure analysis of the subject seals since 1990.**

For ease of review, DuPont responds to this topic as to Ford in Part A below and as to Texas Instruments in Part B below.

A. Since 1990, DuPont has had limited interaction with Ford regarding design, material selection, specification, validation and failure analysis of the subject seal, as follows:

- Ford contacted DuPont by telephone in or about February 1999, inquiring generally about Kapton® FN film, including whether DuPont had test data on Kapton® FN film and brake fluid exposure and whether DuPont was aware of issues with Kapton® FN as used in automotive diaphragms. *See, e.g.*, Ford document entitled "Communications," DD/NHTSA No. 1 00001.

- DuPont responded to Ford by letter through Texas Instruments. *See* DuPont Letter to Brian Digg [sic] of Texas Instruments with attached facsimile sheet, both dated February 23, 1999, DD/NHTSA No. 1 00002 – 00003. In essence, DuPont responded that DuPont lacked test data of the specific sort requested and was unaware of the issues Ford's inquiry appeared to address.

- On or about April 1, 1999, Ford contacted DuPont requesting information about V-0 (flame retardant) plastic products. *See* Ford document entitled "Communications," dated 4/1/99, DD/NHTSA No. 1 00004.

- DuPont responded, forwarding to Ford DuPont product information sheets on Zenite® LCP and Zytel® HTN, and forwarding Zytel® HTN samples to Texas Instruments. *See* DuPont e-mail to Ford dated April 1, 1999, DD/NHTSA No. 1 00005; DuPont Product Information Sheets, DD/NHTSA No. 1 00006 – 00008; DuPont e-mail to Ford dated April 10, 1999, DD/NHTSA No. 1 00009.

Other than contacts in connection with the related litigation (such as interactions between counsel and switch inspections described in response to NHTSA Request No. 7), DuPont has thus far not uncovered other responsive interaction with Ford during the period of inquiry.

B. Since 1990, DuPont has had limited interaction with Texas Instruments in connection with design, material selection, specification, validation and failure analysis of the subject seals, as follows:

- During this period DuPont made sales calls on Texas Instruments related to the sale of DuPont's various high performance films, including Kapton® 500 FN 131. DuPont's role and interaction in this regard was generally that of a raw material/bulk supplier to Texas Instruments of Kapton® products as requested and ordered by Texas Instruments.

- DuPont was aware during this period that Texas Instruments was purchasing Kapton® films for use in automotive switch applications. DuPont was unaware of the particular design of given switches or the specific manner of use of Kapton® within switches or otherwise by Texas Instruments. DuPont furnished its marketing and technical bulletins regarding both Kapton® and Teflon® to Texas Instruments, as DuPont does generally in sales efforts. *See, e.g.*, DuPont marketing and technical bulletins produced in response to NHTSA Request No. 3.

- In or about August 1992, DuPont received an inquiry from Texas Instruments regarding an issue it asserted it was having with Kapton® 500 FN 131 brake pressure diaphragms during cycle testing. *See* notes of Mr. Harrison Gumm, DD/NHTSA No. 1 00010. Texas Instruments subsequently sent DuPont four brake pressure diaphragms and asked DuPont to help Texas Instruments "understand what causes the rupture of these films during . . . cycle testing." *See* letter of John E. Brennan (Texas Instruments) to Harrison Gumm (DuPont) dated August 6, 1992, DD/NHTSA No. 1 00011. In this correspondence Texas Instruments did not identify any vehicle manufacturer(s) associated with these brake fluid pressure switches.

- On August 20, 1992, Mr. Gumm responded to Mr. Brennan, stating that DuPont's initial observations of the failure indicated that the film was damaged in the same location through all three layers; that cracks in the diaphragm were about the same size on all three layers; and that all four diaphragm assemblies had failed in roughly the same geographical area. *See* letter from Harrison Gumm to John Brennan dated August 20, 1992, DD/NHTSA No. 1 00012. Mr. Gumm suggested that the ruptures were caused by higher stresses occurring at the failure site, and that Texas Instruments might consider examining its design for potential causes of localized pressure. *Id.* He noted that such localized pressure could be caused by thickness tolerances of pieces in the assembly, crimping pressures, or other processing parameters that could cause stress. *Id.* DuPont has not located records or other information indicating that it received further information or inquiry from Texas Instruments on this issue. *See* copies of photographs of diaphragms, DD/NHTSA No. 1 00013 - 00039.

- On October 14, 1992, DuPont generated an internal call report following a sales call to Texas Instrument's Attleboro, Massachusetts facility on October 7, 1992. *See* DuPont Memorandum "call report, TI" dated October 14, 1992, DD/NHTSA No. 1 00105. Apparently, Texas Instrument was exploring the sale of switches for automotive applications in Japanese automotive markets and, in particular, seeking to become a preferred supplier of automotive switches to two vehicle manufacturers. *Id.* The call report references Texas Instruments' efforts to gain access to the Japanese market, the desire of potential Japanese customers for additional information on the effect of various automotive fluids on Kapton®, and a desire for additional testing. *Id.* At the meeting referenced in the call report, Texas Instruments asked DuPont for assistance in analyzing various Kapton® products in power steering and brake fluid. *Id.*

- DuPont's Mr. Gumm subsequently received a facsimile from John Brennan of Texas Instruments including a document entitled "Kapton Film Testing Outline", which set forth a test protocol on this topic. *See* facsimile from John Brennan to Harrison Gumm, attaching "Kapton Film Testing Outline," DD/NHTSA No. 1 00040 - 00041; *see also* copy of "Kapton Film Testing Outline" with notes by Harrison Gumm, DD/NHTSA No. 1 00042. The outline indicates that DuPont was to supply Kapton® samples and deliver them to Texas Instruments; that Texas Instruments would age the samples in automotive fluids and deliver those aged samples to DuPont; and that DuPont in turn would test the aged and control samples for tensile strength, percentage elongation at break, modulus, swell and initiation tear strength, and would communicate results to Texas Instruments. *Id.*

- In anticipation of this test program, DuPont prepared 28 envelopes entitled "Texas Instruments' Fluid Testing Program." *See* K & Laboratory Analysis Request [Envelope Covers], DD/NHTSA No. 1 00043 - 00098. Each envelope identified the tests that were to be run on aged and control Kapton®, the type of Kapton®, the specific Kapton® roll number, the date of production, and related information. *Id.* DuPont retained these envelopes in anticipation of receiving aged Kapton® samples from Texas Instruments. DuPont has not located records or other information indicating that it received such samples.

- DuPont received a letter from Texas Instruments dated April 8, 1993, with attached test data regarding Kapton® aged in power steering fluid blended with one percent (1%) water. *See* Letter of John Brennan dated April 8, 1993 with attached data, DD/NHTSA No. 1 00099 - 00104. The test data suggest that that tests were run in

Nissan and Honda power steering fluid. *Id.* Mr. Brennan's letter asserts that results indicate that the Kapton® samples "appear to be mechanically stable in the power steering fluid environment." *Id.* The letter further states that DuPont would receive the "results of the brake fluid aging experiments." *Id.* DuPont has not located records or other information indicating that it received such information.

DuPont does not know for certain the impetus for this 1992-1993 testing effort. As noted above, DuPont believes that it began in connection with one or more requests directed to Texas Instruments by Japanese manufacturers to provide data regarding the performance of Kapton® in automotive fluids, as noted in DuPont's call report referenced above. *See* "call report," DD/NHTSA No. 1 00105.

During the period of inquiry DuPont received other inquiries from Texas Instruments regarding Kapton® 500 FN 131 and Kapton® 200 HN. These inquiries generally involved the inspection program for DuPont films or spooling requirements and product certification issues related to these products. *See generally* DuPont documents submitted in response to NHTSA Request No. 4. DuPont received other inquiries from Texas Instruments during the period of inquiry regarding the use or purchase by Texas Instruments of various types of Kapton® films for use in other automotive switches that Texas Instruments was designing and/or manufacturing or seeking to design and/or manufacture for other vehicle manufacturers, TI's marketing efforts to other vehicle manufacturers, and other general correspondence seemingly unrelated to the subject vehicle, subject switch, or subject seal. *Id.*

DuPont received at least two telephone inquires from Ford and/or Texas Instruments asking miscellaneous questions during the early part of 1999, among which were inquiries about the properties and characteristics of Kapton® 500 FN 131. *See generally* DuPont's response to NHTSA Request No. 1.

Additionally, in or about February 1999, Texas Instruments requested documentation from DuPont regarding the chemical properties of Kapton® HN and of Teflon® FEP. DuPont responded, sending Texas Instruments three charts, one setting forth chemical exposure data on Kapton®, one the chemical properties of Teflon® FEP, and the third the physical properties of Teflon® FEP. *See* DuPont facsimile transmission cover sheet to John Hynes (Texas Instruments) dated 2/25/99, with attached DuPont literature, DD/NHTSA No. 1 00106 - 00109.

These same DuPont documents were produced by both Texas Instruments and Ford in the course of the related litigation, along with what appears to be an introductory summary written by Texas Instruments, which states:

> Water will degrade the mechanical properties of Kapton, but Teflon is unaffected by water. This is the reason why the Teflon-Kapton-Teflon system was selected for Texas Instruments switch diaphragm (3 mil thick Kapton layer coated with 1 mil Teflon on both sides). Page 1 (marked with"A") indicates that the Teflon is non-reactive with water. While page 2 shows Teflon has a relatively low vapor transmission rate (marked with "B"), Page 3 shows how the mechanical properties of Kapton degrade with water and temperature exposure (marked with "C").

See documents produced by Texas Instruments in the related litigation, DD/NHTSA No. 00110 - 00113; documents produced by Ford in the related litigation, DD/NHTSA No. 1 00113 - 00117.

In the late Spring or early Summer of 1999, DuPont received a request from Texas Instruments requesting that DuPont test Kapton® 500 FN 131, 300 FN 929, and 300 HN in an oxalic acid solution. DuPont's test results indicated test failure in oxalic acid solution, which is .5% Oxalic Acid and 95% water, at 90 C. after 6524 hours of submersion. *See* DuPont documents entitled "Oxalic Acid Test Avgs.," DD/NHTSA No. 1 00118 - 00120.

The information for this response was gathered principally in late 1999 and 2000 in connection with related litigation, both from review of DuPonts business files and through interviews with DuPont past and present personnel at DuPont High Performance Films in Circleville, Ohio. Further responsive information was obtained from documents provided by Ford and Texas Instruments, and depositions of Ford and Texas Instruments personnel, during related litigation, and in interviews of DuPont personnel and review of files since receiving NHTSA's June 3 inquiry.[1]

2. Identify the specific type of Kapton® supplied by DuPont to Texas Instruments for use in the subject switches.

1 Because all DuPont information responsive to NHTSA's letter of June 3 was gathered in this manner, DuPont incorporates the foregoing text (and does not repeat it) as part of its response to each numbered request in NHTSA's letter.

Texas Instruments appears to have purchased Kapton® 500 FN 131 and Kapton® 200 HN for use in subject switches. Texas Instruments has purchased a variety of DuPont high performance films for use in various applications since the early 1980s. *See* Texas Instruments documents entitled "Proprietary Information 77PS Overview 2/10/99," DD/NHTSA No. 2 00001 – 00043 at 00002. At the time that Texas Instruments began purchasing Kapton® for inclusion in subject switches, DuPont could not be certain which of its Kapton® high performance films were in fact being purchased for use by Texas Instruments in which switches. Information since obtained through the related litigation and otherwise appears to confirm that Kapton® 500 FN 131 and Kapton® 200 HN were in fact used in subject switches. *See, e.g.* Texas Instruments document entitled "F2VC-9F924-AB MATERIAL ANALYSIS PARTS LIST," DD/NHTSA No. 2 00044; DuPont document entitled "KAPTON® SALES TO TEXAS INSTRUMENT (POUNDS)," DD/NHTSA No. 2 00045; Ford e-mail dated January 25, 1999, DD/NHTSA No. 2 00046; document entitled "Brake Pressure Switch F2VC-9F924-AB Material List for MY 92/93," DD/NHTSA No. 2 00047; diagram entitled "Hydraulic Pressure Switch Cross Section," DD/NHTSA No. 2 00048.

Texas Instruments established specifications for DuPont's supply of Kapton®. Such specifications, among other things, set forth the DuPont film to be used; the size to which the film was to be cut; spooling and packaging requirements; inspection requirements; and the Texas Instruments part number by which DuPont products were to be identified and purchased. *See* Texas Instruments document entitled "Kapton Strip Specification," DD/NHTSA No. 2 00049; Texas Instruments document entitled "Kapton Strip Specification," DD/NHTSA No. 2 00050; Texas Instruments document entitled "Kapton Tape," DD/NHTSA No. 2 00051. Thus, for instance, Texas Instruments designated Kapton® 500 FN 131 as part number 27225-1, and Kapton® 200 HN as part number 74224-1. *See* DD/NHTSA No. 2 00044. Texas Instruments' specification did not require DuPont to alter its standard formulation of either of these Kapton® products, nor did they identify the automotive switch in which the film would be used or the manufacturer for whom the switch was designed or manufactured.

Although, according to Texas Instruments information, the subject switch contains both Kapton® 200 HN and Kapton® 500 FN 131, only Kapton® 500 FN 131 appears to have been used by Texas Instruments in subject seals. *Id.* Kapton® 200HN polyimide film apparently was incorporated into the subject switch by Texas Instruments as a single layer "spacer," not as part of subject seals. *Id.; see also* DD/NHTSA No. 2 00005.

3. **Provide copies of all guides and other documents related in any way to the suitability, durability and/or chemical resistance of Kapton®, and of the subject seals.**

DuPont is producing with its response DuPont product information for Kapton® and Teflon® FEP. *See, e.g.*, DD/NHTSA No. 3 00001 – 00098. DuPont is likewise producing DuPont marketing and technical bulletins produced by Texas Instruments in the related litigation. *See* Texas Instruments production of DuPont marketing and technical bulletins, DD/NHTSA No. 3 00099 - 00327. Kapton® FN is Kapton® HN film coated or laminated on one or both sides with DuPont Teflon® FEP.

Technical product literature of the sort produced here generally describes the properties and characteristics of these products, and is how DuPont commonly communicates to potential customers about those properties and characteristics. DuPont's product information and technical bulletins are broadly disseminated and have been for years, and the characteristics and properties of Kapton® products have been widely known through many industries for many years. Based on such information, and follow-up inquiry as appropriate, customers such as Texas Instruments make decisions regarding "the suitability, durability and/or chemical resistance" of DuPont products in given applications.

During its marketing and sales to Texas Instruments during the period of inquiry, DuPont provided Texas Instruments marketing booklets and technical bulletins describing the properties and characteristics of Teflon® FEP and Kapton®. It appearing that subject seals were manufactured by Texas Instruments from Kapton® 500 FN 131, the characteristics and properties of subject seals should be those described in DuPont's literature, unless the DuPont film was altered or otherwise affected during the manufacturing process or in the operating environment.

Documents produced in response to other numbered requests within NHTSA's June 3 letter also arguably relate to this request, and are incorporated in this response.

Beyond those described here, DuPont is not aware of DuPont documents that relate specifically to "the suitability, durability and/or chemical resistance" of subject seals. Other responsive documents are those in the possession of Ford and Texas Instruments, including documents produced in connection with related litigation. These include: (1) Ford specifications for the subject switch; (2) documents related to Texas Instruments' design, testing and development phase and manufacturing of the switch; and (3) documents related to investigation by Texas Instruments and Ford in response to NHTSA PE98-055. As noted previously in this letter response, DuPont has not produced to NHTSA the entire litigation document production by Ford or Texas Instruments, or the entirety of DuPont's pleadings

and related litigation files. Non-privileged portions of such files can be made available for review at NHTSA's request.

4. **Provide copies of all documents relating to, all communications between DuPont and Texas Instruments regarding the alleged defect in the subject seals. Organize the document copies in chronological order.**

See documents produced in response to NHTSA Request No. 4, beginning with DD/NHTSA No. 4 00001. *See also* Part B of DuPont's response to NHTSA Request No. 1, and DuPont's response to NHTSA Request No. 2, and associated responsive documents.

5. **Provide copies of all documents relating to all communications between DuPont and Ford regarding the alleged defect in the subject seals. Organize the document copies in chronological order.**

See documents produced in response to NHTSA Request No. 5, beginning with DD/NHTSA No. 5 00001. *See also* Part A of DuPont's response to NHTSA Request No. 1, and associated responsive documents.

6. **Provide copies of all technical literature by DuPont or in DuPont's possession relating in any way to the durability, chemical resistance, resistance to automotive brake fluid, resistance to water, brittle failure, fatigue failure, and Teflon® coating failure of the Kapton® material used in the subject seals.**

As noted in response to NHTSA Request No. 3, DuPont is producing with its response DuPont technical product information for Kapton® and Teflon® FEP. *See, e.g.*, DD/NHTSA No. 3 00001 – 00098. DuPont is likewise producing DuPont marketing and technical bulletins produced by Texas Instruments in the related litigation. *See* Texas Instruments production of DuPont marketing and technical bulletins, DD/NHTSA No. 3 00099 - 00327. *See also* DuPont confidential documents, DD/NHTSA No. 6 00001 – 00132.

These marketing and technical bulletins generally describe the properties and characteristics of these products, and are how DuPont commonly communicates to potential customers about its products. DuPont's product information and technical bulletins are broadly disseminated and have been for years, and the characteristics and properties of Kapton® and Teflon® products have been widely known through many industries for years. Based on such information, and follow-up inquiry as appropriate, customers such as Texas Instruments make decisions regarding "the durability, chemical resistance" and potential "failure" characteristics of DuPont products in given applications.

As stated above, during its marketing and sales to Texas Instruments during the period of inquiry, DuPont provided Texas Instruments marketing booklets and technical bulletins describing the properties and characteristics of Teflon® FEP and Kapton®. It appearing that subject seals were manufactured by Texas Instruments from Kapton® 500 FN 131, the characteristics and properties of subject seals should be those described in DuPont's literature, unless the DuPont film was altered or otherwise affected during the manufacturing process or in the operating environment.

DuPont is presently unaware of other DuPont "technical literature" responsive to this request. Insofar as NHTSA means to include within this term testing, DuPont notes that, in 1989, DuPont polyimide films personnel conducted tests of various Kapton® and Pyralux® (i.e., copper-coated Kapton®) films in a variety of automotive fluids, including brake fluid, at the request of a company that was attempting to develop sales of various high performance products within the automotive industry. *See* DD/NHTSA No. 6 00140 – 00165; *see also* DD/NHTSA No. 6 00166 - 00178. The automotive fluids analyzed included: M-85 (85% Methanol, 7.5% toluene, 7.5% Iso-octane); M-15 (15% Methanol, 42.5% toluene, 42.5% Iso-octane); Automatic Transmission Fluid (ATF) - "Dexron ATF"; GM Sour Gas - Indolene HO3 (Amoco)/.0028% T-Butyl Hydroperoxide (90%); Brake Fluid - "Berkebile" 2+2" DOT-3; Antifreeze - "Peak" (full concentration); Detergent - "Joy" (50% concentration dish washing liquid in water); Salt Solution (saturated 1511.7 grams NaCL/13602.3 grams water); Battery Acid - H2SO4 (spec. grav. 1.265); Isopropyl Alcohol (full concentration); 1,1,1 Trichloroethane (full concentration); Caustic Cleaner (PH > 10) (tap water/0.05% Trisodium Phosphate). *See* memorandum of Mark McAleer to Doug Wells and attachments, DD/NHTSA No. 6 00140 - 00165; "Automotive Fluid Testing", DD/NHTSA No. 6 00166-00178. The films tested included: Kapton® 300 HN (PMDA) (3 MIL); Kapton® 300 EP; Kapton® 300HMK; 3 MIL UBE-S; 100 EP LF-0111 (5457-0616); 100 HMK LF-0111 (5457-0677); and 1 MIL UBE-S. *Id.* Although not originally part of the test protocol, Kapton® 200 FN 919 was added later to the program after automotive fluid tests were underway or completed, and in some cases was not tested in the full range of automotive fluids involved. *Id.* No data is reported for 200 FN 919 in any test except for limited "MODULUS" testing in ATF, sour gas and M-85. The 200 FN 919 was not tested in brake fluid. *Id.*

The Kapton® films tested in brake fluid were tested at room temperature. *Id.* As the documents reflect, the Kapton® films tested were reported to have performed well in brake fluid. The data show some deterioration in tensile strength. *Id.* Some change was noted in the elongation test. *Id.* The modulus did not change from immersion in the brake fluid. *Id.*

7. **Describe, and provide copies of all documents relating to, any and all inspections, tests, and other analyses conducted by DuPont on field return or lab test specimens of the subject seals.**

DuPont has performed visual observations on field-returned and lab test specimens of subject seals. Over the course of the related litigation, a materials expert retained by DuPont, John Slater, Ph.D., attended inspections of subject vehicles and recall vehicles, and in certain instances attended the breakdown of a subject switch taken from or recovered from a vehicle involved in a fire event and inspected and photographed the diaphragm recovered from the switch. Dr. Slater also inspected and photographed diaphragms at a Texas Instruments facility in Massachusetts, and at a Ford laboratory in Michigan.

More specifically:

- In February 2000, Dr. Slater visually inspected and photographed a series of diaphragms at a Ford laboratory in Dearborn, Michigan. The diaphragms were specimens from a 77PS Wear Correlation Test, conducted at an earlier date by either Texas Instruments or Ford. Dr. Slater also visually inspected and photographed two of the three diaphragms from a failed switch identified by Ford as the "Memphis" switch. Dr. Slater also visually inspected and photographed three diaphragms from a failed switch identified by Ford as the "Baton Rogue" switch. *See* inspection photographs, DD/NHTSA No. 7 00001-00013.

- In May 2000, Dr. Slater observed and photographed diaphragms at a Texas Instruments facility in Massachusetts. The diaphragms consisted of two separate sets of diaphragms: sixteen test diaphragms that had been cycle-tested, and 13 diaphragms from field returned recall switches. *See* inspection photographs, DD/NHTSA No. 7 000014-00092.

- In June and July 2000, Dr. Slater observed and photographed the disassembly of three switches that had been removed from vehicles within the subject recall, each of which had been subjected to a vehicle fire. The switches were reportedly removed from a 1993 Lincoln Town Car and from two 1992 Lincoln Town Cars. *See* Dr. Slater's inspection photographs, DD/NHTSA No. 7 00093-00145; *also see* digital photographs taken by Anderson & Associates, DD/NHTSA No. 7 00146-00355.

- In August 2000, Dr. Slater observed and photographed the disassembly of a single deactivation switch removed from the "Campbell" vehicle in Mississippi, which had been involved in a fire event and resulted in litigation against Ford, Texas

Instruments and DuPont. A fire investigator identified an aftermarket wire as the cause of the fire. *See* Campbell switch disassembly photographs, DD/NHTSA No. 7 00356-00412.

- In August 2000, along with observers from Ford and Texas Instruments, Dr. Slater observed and photographed the disassembly in Detroit, Michigan by an outside consultant, Exponent, Inc., of three field-returned recall switches. The examined switches were selected by Ford or others before inspection and disassembly apparently because of an electrical anomaly identified in each switch through a criteria and at a time unknown to DuPont from a larger population of field-returned switches. *See* inspection photographs, DD/NHTSA No. 7 00413-00452.

- In May 2003, Dr. Slater observed and photographed the disassembly of a single deactivation switch removed from a 1997 F-150 series pickup truck, which had been involved in a fire event and resulted in litigation against Ford, Texas Instruments and DuPont. The vehicle was not within the subject recall. The hexaport portion of the switch was removed from the vehicle and disassembled by experts for Ford, Texas Instruments, DuPont, and Allstate Insurance Company, the insurer of the vehicle's owner. Following disassembly, both Allstate and plaintiffs amended their petitions to include a cause of action against Ford unrelated to the deactivation switch; the amended petition did not name Texas Instruments or DuPont. *See* "Everts" switch disassembly photographs, DD/NHTSA No. 7 00453-00495.

DuPont also incorporates its response to NHTSA Request No. 8(K), which discusses DuPont's inspection of seals furnished to DuPont by NHTSA.

Although DuPont has inspected other vehicles involved in fire events and observed and photographed the vehicle and the switch when still in existence, DuPont has not inspected or observed the disassembly of other subject switches or inspected or photographed other diaphragms from subject vehicles or recall vehicles.

All photographs produced with this response were taken by Dr. Slater during DuPont's investigation in related litigation, except for the digital photographs taken by Anderson & Associates, which were taken with Dr. Slater and the representatives of the other parties present.

8. Provide DuPont's assessment of the alleged defect in the subject seals.

As indicated above, and in the course of DuPont's meeting with NHTSA of July 31, 2003, DuPont was not involved in specification, design or manufacturing of subject vehicles, subject switches, or subject seals, and has been involved only minimally in analysis of subject switches and subject seals. Accordingly, DuPont's ability to provide meaningful assistance at this time with respect to much of NHTSA Request No. 8 is limited. That said, DuPont offers the following.

Include in your response the following information:

A. An assessment of the failure mechanism:

Based on DuPont's limited observations of Kapton® contained in switches disassembled following testing or after removal from vehicles, it appears that the "failure" in this application – to the extent the failure may relate to degradation of Kapton® -- may occur in a limited number of switches by one or both of two mechanisms.

The first is normal "end of life" failure. This mode of failure can occur as a result of the fundamental function of the switch in responding to brake pedal applications which cause intermittent pressurization of the brake system. During this process, the Kapton® seal is subjected to repetitive cyclic loading, which can set up a fatigue situation in both the Kapton® and in overlying Teflon® FEP layers.

Fatigue is a familiar phenomenon experienced by many materials, metallic and non-metallic. Fatigue of Kapton® in this particular application is likely typically manifested by the formation of cracks at the point of cyclic stresses, whose magnitude is below the yield or "stretch" point of the material. This form of deterioration appears to start on the Kapton® layer closest to the electrical side of the switch, presumably because the highest stresses occur on this side due to contact with the washer and transfer pin. The cracking generally appears circumferentially around the "O-ring" seal area or around the transfer pin contact area on the Kapton® seal. In time, this degradation mechanism may perforate the first Kapton® layer and may proceed to propagate through the other Kapton® layers, ultimately leading to brake fluid leakage into the electrical side of the switch.

This appears to be the "normal" mode of failure in this type of cyclic service. It may be accelerated or decelerated by a number of conditions, from imposition of higher or lower cyclic stresses (resulting, for instance, from differences in "travel" found between so-called "quiet" and so-called "noisy" switches) to possible differences in

roughness of the surfaces with which Kapton® and Teflon® FEP make contact. It is also conceivable that degradation may be accelerated by hydrolytic deterioration of the Kapton®, due to ingress of aqueous fluids into the electrical side of the switch, which fluid may then come into contact with the outer layer of the Kapton® film.

A second mechanism for possible Kapton® deterioration appears to involve locally high stresses imposed on the Kapton®/Teflon® FEP composite. This appears to result in radial distortion and tearing of Teflon® FEP, often with delamination, and eventually in cracking of Kapton®. The cracking of the Kapton® is probably due to the imposition of service cyclic stresses in addition to high localized stresses, leading to early fatigue. Such cracking may also result from hydrolytically induced degradation of mechanical properties of the Kapton®. This could be caused (1) by water-contaminated brake fluid penetrating a cracked Teflon® FEP layer; (2) by water penetrating a stressed – and thus more permeable – Teflon® FEP layer, or (3) by some combination of both mechanisms described in (1) and (2). Once brake fluid has penetrated the initial layer of Teflon®/Kapton®/Teflon®, the process may repeat into the second layer, and eventually into the third. However, based on observations and the extended lifetime of switches, it appears that the third layer of the composite (the one nearest to the switch's electrical side) may at times crack due to the "normal" degradation mechanism detailed above, enabling access of brake fluid to the electrical side of the switch.

This second phenomenon has been observed in subject switches removed from vehicles within the subject recall. Locally high stresses may be associated with the switch's "crimping" assembly process used to integrate the mechanical portion of the switch together. This activity may also be associated with the formation of so-called "teardrops" in the switch, which have been observed after disassembly and inspection of seals both within and outside the recall population.

Other issues potentially related to the failure mechanism in question are discussed below.

B. An assessment of the long term resistance of the subject seals to automotive brake fluid at 100'C, 120'C, and 150'C

DuPont has not conducted such an analysis, and lacks data that would permit a meaningful assessment. The only long-term (*e.g.*, "end use") testing of this sort known to DuPont is that performed by Texas Instruments as described in information produced in the related litigation.

Given the chemical composition of DOT 3 brake fluids, which DuPont understands to be based on polyalkylene glycol ethers, no significant deterioration would be expected of Kapton® exposed to such brake fluids alone. Brake fluids may absorb water, however, particularly as they age. If water-contaminated brake fluid comes into contact with Kapton® in this application, hydrolysis and degradation of Kapton® would be expected to occur in some instances given the well-known hydrolytic properties of Kapton® (as of other polyimides). The extent (if any) to which hydrolysis occurs is a function of a number of variables, from the concentration of water to the amount of time water-contaminated fluid is in contact with Kapton® to associated temperatures. This hydrolysis in turn could lead to degradation of the mechanical properties of Kapton®, including fatigue strength. Contact with Kapton® could occur if the Teflon® FEP overlay were breached or became more permeable to water as the result of applied stresses.

C. **An assessment of the estimated service life of the subject seals in hours and pressure cycles when subjected to the conditions described in 8.b - include in your response the estimated service life at each condition at which tensile strength, tear strength (initial), tear strength (propagating), and ultimate elongation will be reduced by 50 percent of their initial values;**

DuPont has not conducted such an analysis, and lacks data that would permit a meaningful assessment. DuPont is not knowledgeable about the service life of the subject seals in this application, nor has it conducted testing that estimates service life. Indeed, given the small size of the individual layers of the Kapton® seals, DuPont understands that the diaphragms manufactured by Texas Instruments for the subject switch are too small to be effectively subjected to standard ASTM test methodologies.

D. **An assessment of the design factors of the subject switches that may influence the durability of the subject seals;**

As indicated above, Dupont is not knowledgeable about the actual "design factors" of the subject switches, since DuPont did not participate in their design. Subject to this important caveat, the following parameters within the purview of design are among those that may influence the durability of the subject seals:

-- applied steady load on the seals (due, for instance, to crimping);
-- applied cyclic load on the seals (due to pressure cycles); and

-- the nature of the surface (roughness, plating, and so forth) of components contacting the seals.

Accordingly, design specifications and other such items from the design phase of the subject switch and the subject vehicles that address these durability factors would be responsive to this request. DuPont respectfully suggests that such information is more likely within the possession of Ford and Texas Instruments.

E. An assessment of the manufacturing factors of the subject switches that may influence the durability of the subject seals;

As indicated above, Dupont is not knowledgeable about the actual "manufacturing factors" of the subject switches, since DuPont did not manufacture the switches. DuPont has not conducted an independent analysis of such "manufacturing factors." Subject to this important caveat, DuPont has previously in this letter response discussed the impact of localized stresses and loads as a potential factor in the failure mode at issue, and has identified crimping as a possible source of localized stresses. Since crimping is a "manufacturing factor"; since crimping may influence the durability of the subject seals; and since crimping was the subject of much discussion at the time of the subject recall, it is responsive to this topic.

F. An assessment of the use factors of the subject switches that may influence the durability of the subject seals;

Dupont is not knowledgeable about the specific "use factors" of the subject switches within the subject vehicles. Nor, other than as described elsewhere herein, does DuPont have data on such factors and their potential effect on durability of the subject seals. Subject to this important caveat, it appears that "use" factors that would potentially affect the subject seals include:

-- nature of the environment (for instance, the type, contamination and temperature of the brake fluid);
-- longevity of exposure to brake fluid; and
-- the number of pressure cycles imposed on the seals.

G. A description of factors that can contribute to brittle failure of the subject seals;

DuPont understands "brittle failure" as used here to mean rupture at applied stresses below that expected based on "normal" tensile properties. Given this definition, it

appears, as suggested above, that two principal factors could contribute to brittle failure: hydrolysis and fatigue.

Both factors have been described above in response to previous topics. The possibility of hydrolysis in the brake fluid environment may be related to perforation of the overlying Teflon® FEP film and the water content of the brake fluid. Another contributing factor may be increased temperature. Fatigue can also cause "brittle failure." Factors affecting fatigue include the presence and magnitude of any mean tensile stresses, and the magnitude and number of the cyclic stress events.

H. An assessment of factors that can contribute to failure of the Teflon® coating of the subject seals;

The "sandwiching" of Kapton® between Teflon® FEP layers in Kapton® 500 FN 131 material was initially designed by DuPont to allow inter-layer heat sealability of the composite. Although DuPont did not direct Texas Instruments' selection of this (or any other) material for use in the subject switch, it appears that in this application Teflon® FEP layers are utilized to provide anti-friction or lubricity properties, together with general chemical inertness and their tendency to "shield" the Kapton® against possible hydrolytic agents.

DuPont understands "failure of the Teflon® coating" to describe the inability of the Teflon® FEP layers to perform these functions. The discussion above regarding possible failure mechanisms addresses the possibility of damage to these layers of the subject seals. If the Teflon® FEP is damaged or is not intact, its ability to act as a barrier may be compromised. Cracking or tearing of the Teflon® FEP could occur due to fatigue (such as from cyclic stressing) or to mechanical damage (such as, for example, stress from manufacturing factors such as crimping).

Mechanical damage could also lead to delamination of the Teflon® FEP even in the absence of cracking. This could influence both the lubrication ability for the composite as a whole, and possibly could allow contaminated brake fluid to be trapped against the Kapton® layers in the bubble or blister thus formed.

I. An assessment of factors that could influence crack orientation and propagation in the subject seals;

Cracking of the Kapton® seals or diaphragms appears to be either circumferential (related to normal "end of life") or radial (related to "premature" failure). Factors

that could influence these different types of cracking appear to include the general and localized stress on the Kapton® composite as influenced by both design and manufacturing processes. The nature of crack "propagation" (understood here to mean the first method of seal failure, either fluid or electrical side) and the process that may cause it have been discussed above. Again, these factors are influenced by the stress state on the seals, as defined by design and manufacturing processes.

J. An assessment of the failure mechanisms of the subject seals specimens sent with this letter;

DuPont respectfully submits that its response to NHTSA Request No. 8(K) addresses this topic as well.

K. Dupont's assessment of the condition, failure mechanism and material properties of the two included Kapton® seal sets.

NHTSA forwarded two sets of seals with its June 3, 2003 letter to DuPont. The first set was still contained within the mechanical portion of an apparently used switch, from which the crimp ring had been removed and was not included. The "cup" had been sectioned peripherally. The electrical portion of the switch, including the transfer pin, was not included with the portion of the switch forwarded to DuPont. The second set included only the three diaphragm layers, each of which was individually contained within a separate plastic mini-petri dish, labeled P1, P2 and P3.

DuPont's assessment of these seal sets was a central subject of the meeting between DuPont and NHTSA of July 31, 2003. As discussed then, DuPont examined the diaphragms contained in the mini-petri dishes under binocular magnification, and photographed the diaphragms using 35 mm equipment and up to 10x digital equipment. The so-called "teardrop" phenomenon, with associated radial cracking of both the Teflon® FEP and the Kapton® and delamination at the Kapton®/Teflon® FEP interface, was observed on each diaphragm. Because the individual diaphragms were not "match-marked," their relative orientations could not be determined with confidence. However, it appears that the "teardrop" on each layer can be overlaid, and that by this method a "typical" arrangement for the three diaphragms within a switch can be reconfigured.

The diaphragms contained within the mechanical portion of the apparently used switch were removed from the switch. Photographs were taken of each diaphragm

in this set. The adjacent corners of the diaphragms were marked, depicting the position of the layer within the diaphragm "sandwich" (closest to fluid versus the middle versus closest to electrical). This series of diaphragms also exhibited "teardrops" with apparent tearing and delamination of the Teflon® FEP and radial cracking of the Kapton®, but only in the two layers closest to the fluid. The electrical side diaphragm showed circumferential cracking typical of "end of life."

See copies of photographs, DD/NHTSA No. 8 0001-0149.

9. **Provide the name and contact information of a DuPont representative that can answer technical questions concerning the subject of this letter.**

DuPont's retained materials expert Dr. John Slater has been and will be made available to answer technical question concerning the subject of NHTSA's letter. To confer with Dr. Slater, please contact the undersigned or contact Mr. John F. Kane at DuPont, D-4022-1, 1007 Market Street, Wilmington, DE 19898; by telephone at 1-800-224-4480 ext. 4-7892; or by fascimile at 1-302-774-5454.

* * * *

As the foregoing hopefully demonstrates, DuPont has endeavored to respond fully and accurately to NHTSA's inquiry. DuPont's limited role and involvement with subject vehicles and subject switches necessarily limits its pertinent knowledge and its responsive information. As indicated, DuPont did not participate with Ford in establishing specifications for the subject switch or subject vehicles, nor with Texas Instruments in the design or manufacturing of the subject switch or subject seal. Nor is DuPont sufficiently expert in the vehicle or switch environment at this time to recreate the actual automotive operational environment in which these switches functioned when installed on subject vehicles.

DuPont's effort to locate and provide information responsive to this request focused upon DuPont's present and past personnel most knowledgeable about the subject matter of this inquiry; a review of DuPont files in which responsive information ordinarily would be expected to be found and to which DuPont would ordinarily refer; documents produced by both Ford and Texas Instruments in the related litigation; and interaction with retained consultants.

DuPont hopes that this response has been helpful. We stand ready to assist NHTSA further insofar as we can be of further assistance.

Sincerely,

Scott L. Winkelman
Counsel to DuPont

cc: Mr. Jeffrey L. Quandt (w/o enclosures)

Enclosures (responsive documents and disk)

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