Glass Fiber Contamination of Cigarette Filters: An Additional Health Risk to the Smoker?¹


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Abstract

We report here the results of studies documenting the contamination of a cigarette-appearing smoking article labeled Eclipse with glass fibers, fragments, and particles. Eclipse, a product of the R. J. Reynolds Tobacco Company (RJR), was commercialized in June of 1996. Eclipse is unlike conventional cigarettes in that, like its predecessor Premier, it is designed to heat and not burn tobacco. The purpose of Eclipse was to simplify the chemical composition and reduce the biological activity of the mainstream and sidestream smoke and to achieve a significant reduction of environmental tobacco smoke. In Eclipse, tobacco pyrolysis is reduced by a carbon fuel rod that serves as a heat source for generating an aerosol having nicotine and tobacco flavor. The carbon rod, at the tip of the cigarette, is insulated and bound with two wrapping mats of glass fibers. Recently, Eclipse has been modified to address consumer complaints of burdensome draw and off-taste. The redesigned Eclipse, which we have termed the New Eclipse, has an unconventional filter-appearing mouthpiece that consists of a cellulose acetate cylindrical bundle with a central hollow tunnel. In our analysis of Eclipse, glass fibers (length:width aspect ratio, ≥3:1) were: (a) observed protruding from the tip; (b) identified on the white cigarette wrapping paper; (c) viewed on the surface of the cork-appearing tipping paper; (d) found in the pack residue; (e) discovered lying freely on the cut surface of the filter by both light and electron microscopy; (f) harvested from the filter with adhesive tape; and (g) displaced when Eclipse was smoked mechanically. In a study of Eclipse that had not been removed from carefully opened packs, we observed that ≥95% of the filters were contaminated with glass fibers (Eclipse: Regular, n = 114/120, 95%; Milds, n = 118/120, 98%; Menthol, n = 120/120, 100%). Likewise, 99% of NEW Eclipse had glass fibers on the redesigned filter (Regular, n = 119/120). In contrast, glass fibers were never observed on the filters of conventional United States filter cigarettes that had been used as controls (n = 0/120, 0%). In a study of Eclipse (n = 60), the number of glass fibers contaminating the filter surface ranged from 5 to 55. Glass fibers as well as fiber fracture items [aspect ratio, <3:1 (e.g., particles, fragments, bits, chips, flakes, specks, and dust)] were discovered in the pack residue. The average number of glass fibers in the residue of a pack of Eclipse was 7,548 (SE ± 3443; range, 1,164 to 26,725 glass fibers/pack; n = 7 packs). The thin and fragile glass fibers of the insulation mats had most likely been broken and fragmented in the high-speed multiple-step Eclipse manufacturing operation. Invariably, puffing on Eclipse discharged glass fibers and glass particles from the filter into the smoker’s mouth. Subsequently, the bioreistant glass fibers and microscopic glass dust are inhaled and/or ingested. Contamination of Eclipse filters with glass fibers and glass dust poses a potential and unnecessary health hazard to uninformed consumers. Eclipse is a paradigm of the health danger that may be imposed by technically complex tobacco articles and nicotine delivery devices promoted by an unregulated industry to smokers worldwide, many of whom are addicted to nicotine and who seek a less hazardous cigarette.

Introduction

In 1987, RJR³ announced Premier, and a market test was conducted from October 1988 through February 1989 (1–4). Premier was one of several smoking articles defined by RJR as “NEW CIGARETTE Prototypes That Heat Instead Of Burn Tobacco” (1–11). The stated objectives of these cigarette-appearing devices, as set forth in an RJR monograph (10), were to: (a) simplify the chemical composition of mainstream and sidestream smoke emitted by the “NEW CIGARETTE” (10); (b) minimize the biological activity of the mainstream and sidestream smoke emitted by the NEW CIGARETTE; and (c) achieve significant reduction of environmental tobacco smoke from the NEW CIGARETTE (see also RJR reports, Refs. 6, 12, and 13).

The performance of Premier in the market evaluation was poor (2–5, 7, 8, 11). Smokers rejected Premier because of off-taste, difficulty in lighting, and other problems (2–5, 7, 8, 11). Premier was reconfigured to address these shortcomings

¹The abbreviations used are: RJR, R. J. Reynolds Tobacco Company; SEM, scanning electron microscopy; SEM/EDX, SEM energy dispersive X-ray microanalysis; NTP, National Toxicology Program: PAH, polycyclic aromatic hydrocarbon.
(2–5, 7, 8, 11). After 3 years of development, Eclipse was introduced (2–5, 7, 8, 11). Features of Premier and Eclipse have been described in more than 20 U.S. Patents (9, 10), and patent protection has been sought in more than 110 countries (10).

In June of 1996, Eclipse began selling in Chattanooga, TN (1, 3). Soon thereafter, the market test was expanded. In 1998, Eclipse is being sold in other United States cities. Additionally, Eclipse is being sold in different countries under various trade names (Ref. 1; see "Materials and Methods"). In September of 1997, RJR introduced a modified version of Eclipse to Lincoln, NE ($2.69 per pack, including tax; Ref. 14). We have designated the reengineered Eclipse as the NEW Eclipse. When compared with the original Eclipse, significant changes in the NEW Eclipse included: (a) improved lighting; (b) filter modification; (c) more tobacco taste; and (d) 80% less secondhand smoke; the corresponding value cited by RJR for the original Eclipse was 90% (14).

Eclipse has the outward appearance and geometry of a conventional cigarette (Refs. 1, 3, 4, 9, and 10; Fig. 1) and is obtainable in four king-size styles: Regular, Milds, Menthol, and Menthol Milds (1, 3).

Opening Eclipse with a razor (Fig. 1) revealed that it is a multiple component, technically sophisticated smoking device having many items not found in conventional cigarettes (1–5, 7, 9). Essential to the design of both Premier and Eclipse was the goal that tobacco pyrolysis was to be reduced greatly (6, 10). This was accomplished with the use of a carbon fuel rod (Refs. 1, 3, 4, and 6–10; Figs. 1 and 2, a and b) that, when ignited, would heat reconstituted tobacco to generate a low-smoke nicotine containing aerosol that imparts a tobacco taste (1, 3, 4, 7, 9, 10).

Unlike a conventional cigarette, Eclipse does not burn down to the filter when smoked; the spent Eclipse retains its length (Fig. 1; Refs. 4, 9, and 10). When smoked, Eclipse displays an ash-appearing tip that consists mostly of an insulation mat of glass fibers (Fig. 1; Refs. 1, 4, 9, and 10). Eclipse burns very little paper, which, in conventional cigarettes, is impregnated with burn accelerators and smoke modifiers (Fig. 1; Refs. 10 and 15). The burning (∼900°C; Refs. 4 and 10) carbon rod is insulated with two glass fiber mats (Fig. 1; Refs. 4, 9, and 10). The primary function of the glass mats is to: (a) secure the position of the carbon fuel rod; (b) insulate the burning rod; and (c) direct the heat from the rod to the adjacent tobacco column (10). Other components of Eclipse have been described in detail elsewhere (9, 10).

The Eclipse filter resembles that of a conventional cigarette; however, the filter rod has been truncated and is approximately one-third the length (Fig. 1; Refs. 3, 9, and 15). The filter rod of conventional cigarettes consists of thousands of Y-shaped cellulose acetate fibers (Ref. 16; see also Ref. 15). Y-shaped cellulose acetate fibers that are similar in appearance are used in the filters of Eclipse and NEW Eclipse.

Observations obtained in our initial inspection of Eclipse raised concern that the thin and fragile glass fibers of the insulation mats may break during manufacturing and contaminate the surface. To address this hypothesis, a study was conducted to: (a) determine whether the glass fibers and particles are present in the pack residue and the surface of Eclipse; and (b) if present, is there evidence to assume with reasonable certainty that the glass fibers would be inhaled and/or ingested when Eclipse is smoked as intended. The rationale for undertaking these studies is derived from part animal and human studies that have for many years addressed the health risks of inhaled glass fibers; in evaluating these findings, it was concluded in 1994 that: "From our comprehensive review of the available information, we conclude that fibrous glass materials are carcinogenic. . ." (17).

Materials and Methods

Eclipse, NEW Eclipse, and Conventional Cigarettes. Eclipse from RJR was the test article of this study. The Regular, Milds and Menthol Eclipse articles were purchased from 1996 through 1997 from retail vendors in Chattanooga, TN. The NEW Eclipse articles were bought from retail stores in Lincoln, NE and Chattanooga, TN; these were procured in 1998. We analyzed also Eclipse that had been licensed by RJR for sale in Sweden (Inside, Regular, and Menthol; Svenska Tobaks, AB, Stockholm, Sweden), and in Germany (HiQ, Regular; German subsidiary of RJR).4 Premier smoking articles from RJR were provided by colleagues who had purchased them during the test market period from retail dealers. Conventional United States filter cigarettes were used as controls. The conventional cigarettes were of different: (a) brands (e.g., premium and discount); (b) manufacturers (e.g., RJR and other United States tobacco companies); (c) styles (e.g., Regular, Mild, and Menthol); and (d) packaging (e.g., hard and soft pack). All had been purchased from retail merchants in Erie County, NY.

Inspection of Eclipse and Conventional Cigarettes. Packs of Eclipse and conventional cigarettes were opened carefully in the laboratory and by personnel familiar with the purpose and scope of our investigation. Safeguards were used to protect both Eclipse and conventional cigarettes from airborne fiber and particle contaminants. A partial listing of the precautions used are as follows: (a) after un wrapping and discarding the cellophane film, the flip-top lid was reflected and taped to maintain the pack in an open position. The front aluminum foil was lifted off carefully and discarded. The back aluminum foil was removed by cutting with clean scissors. All manipulations were performed without contacting or moving the Eclipse. Particular care was exercised in not touching the filter, the major test site of this study; (b) Eclipse articles were examined immediately after opening the package so as to reduce the exposure and risk to contaminants; (c) the filters were inspected for glass fibers without removing the Eclipse or conventional cigarettes from the pack. After inspection of the filters for glass fiber contaminants, the top was closed, and the pack was stored in a stationary upright position in a closed plastic container; (d) conventional cigarettes, which had been handled in a similar manner, were used as assay controls; (e) for some tests, the Eclipse and conventional cigarettes were taken out of the pack. In these assays, examinations for glass fibers and particles were conducted immediately after removing the Eclipse and conventional cigarettes; and (f) samples for SEM or SEM/EDX were transported and stored in closed boxes and examined immediately after removing.

Examination of the Tip of Eclipse. The tip of Eclipse was inspected to assess the integrity of the two glass fiber insulation mats. For this evaluation, a pack was inverted, and the paperboard was cut carefully from the bottom of a pack with scissors (Fig. 2) without contacting or disturbing the Eclipse articles. The tip was scrutinized with a stereo-zoom microscope. After completing the microscopic examination of the glass mats and carbon rod, the Eclipse articles were removed carefully and individually with forceps from the pack and positioned at

4 Eclipse is also marketed in Japan (AIRS); however, AIRS was not available for our study.
brane was removed and dried at 56°C in a covered plastic Petri dish. Each filter face, and portions thereof, was processed in the same manner but which contained either: (a) no pack residue (i.e., microscope slide and micropore membrane control); or (b) residue from packs of control cigarettes. For nonquantitative morphological and chemical analysis, the residue was collected directly (e.g., no water, no membrane, no drying, and no mounting) onto a glass microscope slide or SEM stub (see below).

Fibers, defined by the National Toxicology Program (United States Department of Health and Human Services), were recognized as structures having a length:diameter aspect ratio of 3:1 or greater (18). Glass structures having an aspect ratio of <3:1 were defined as particles; the term particle is used herein as a generic term that includes other descriptive expressions including fragments, flakes, bits, chips, specks, and dust. In identifying glass fibers and particles by polarized microscopy, we used protocols and schema used routinely for fiber identification by forensic scientists (19). Unlike all other fibers and particles, glass items do not polarize light; this is defined as isotropic (19). This unique optical property, transparency, size [i.e., diameter(s)], cross-sectional shape, surface morphology, color, terminus (i.e., end) appearance, and other optical and morphological characteristics were used to distinguish Eclipse-derived glass fibers and glass particles from other items found in the pack residue.

Filter Tipping Paper Tested for Glass Fibers. The surface of the cork-appearing tipping paper of Eclipse and conventional cigarettes was tested for glass fibers. For this purpose, the filter was rolled one complete rotation on a strip of clear adhesive tape. The tape was then adhered to a clean microscope slide, and the number of glass fibers collected was enumerated with a microscope configured for viewing with white and polarizing light.

Filter Surface Examined with a Stereo-Zoom Microscope. Packs of Eclipse and conventional cigarettes were opened, as described above, and the faces of the filters were inspected for glass fibers with a stereo-zoom microscope (Stereomaster; Fisher Scientific). Each filter face, and portions thereof, was

**Fig. 1.** Components of Eclipse. **Upper panel,** nonsmoked Eclipse; **middle panel,** Eclipse after being completely smoked; **lower panel,** nonsmoked Eclipse that had been cut open to illustrate: a, carbon fuel rod; b, insulation mats of glass fibers; c, tobacco paper; d, column wrapping of white paper with an interior laminate aluminum foil heat barrier; e, distal column of reconstituted tobacco; f, proximal column of reconstituted tobacco; g, tipping paper with a cork-like appearance; h, laser-generated holes for side-stream ventilation and smoke dilution (we have enlarged the size of the holes to facilitate viewing their position and number); and i, filter of cellulose acetate fibers. Eclipse length, 83 mm.
scrutinized without removing the articles from the pack. Initially, the field of observation was adjusted to permit imaging of the whole filter (15-fold magnification; ×1.5 objective and ×10 ocular). For a more detailed viewing of the filter, we used the variable magnification afforded by the stereo-zoom optics. The magnification was usually within an ×8 to ×40 range. The resolution at these magnifications was about 73 and 135 lines/mm, respectively.

Glass fibers upon and within the Eclipse filter were seen using a conventional stereo-zoom microscope and standard illumination. We learned, however, that better viewing of the glass fibers was achieved with dual gooseneck fiber-optic lamps from a 4.8-W halogen light (Dolan Jenner Industries, Inc., Lawrence, MA). The lamps were placed in an opposing left- and right-hand position. Each lamp was positioned at an oblique angle, usually 5° to 15° to the horizontal.

The advantages afforded by this illumination scheme were as follows: (a) the Eclipse and conventional cigarette filter are composed of numerous cellulose acetate fibers, and these fibers are oriented longitudinally to form the cylinder-shaped filter plug. Microscopically, the on-end view of the filter fibers revealed a carpet-like appearance. Inspection of glass fibers on this morphologically complex surface at high-power required precise focusing; (b) both the glass and cellulose fibers are translucent. Furthermore, light was reflected from the smooth surface of both fiber types. When compared with vertical lighting, oblique shadow-casting illumination provided better dimension and enhanced the contrast of the glass and cellulose acetate fibers; and (c) glass fibers and particles were seen both atop and within the column of large cellulose acetate fibers. Consequently, resolving the glass at different depths within the filter was facilitated by adjusting repetitively and simultaneously both the illumination and focus.

We established the following technique whereby the filter of each Eclipse in a pack could be analyzed efficiently and expeditiously for glass fibers with a stereo-zoom microscope. In this method, one hand was positioned on one of the gooseneck halogen lamps to direct oblique lighting onto the cut surface of the cigarette filter, while the other hand was used simultaneously to adjust the focus of the microscope.

**Fig. 2.** Glass fibers in Eclipse. *a,* two packs of Eclipse, as viewed after inverting and removing the bottom wrapping paper. *b,* close-up view of Eclipse, from the previous panel. Illustrated are the two mats of glass fibers that sandwich the tobacco paper (black arrow). Also shown is the carbon fuel rod that is insulated by the glass mats. Open arrow, a bundle of glass fibers displaced from the insulation mats. *c,* detailed view of the tips of two Eclipse articles that illustrates a multitude of glass fibers that form the insulation mats and carbon particles (arrow) displaced from the fuel rod. *d,* glass fibers protruding from the tips of two Eclipse that had been removed carefully from a freshly opened pack. Arrow, one of several glass fibers that were seen on the surface of the cigarette. *e,* view with a light microscope of the residue of a pack of Eclipse. Shown are numerous glass fibers of variable length. Also illustrated are glass fiber-derived particles, three of which have been denoted with an arrow (×50). *f,* view with a SEM of the broken end of a glass fiber that was found in the pack residue of Eclipse. Binder is present as randomly dispersed amorphous dabs as well as a film-like substance (arrow) dripping from the glass fiber surface (bar, 1.0 μm).

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H. Kaneko (Carton Optical Industries, Tokyo, Japan), personal communication.
touched to the adhesive side of the tape. Immediately thereafter, the same filter was touched a second time to an adjacent spot on the tape. The tape was then pressed, sticky-side down, onto to the same filter was touched a second time to an adjacent spot on the adhesive side of the tape. Immediately thereafter, the same filter was touched a second time to an adjacent spot on the adhesive side of the tape. The test filter was glued in an upright position upon an aluminum SEM stub. The filter was coated with gold (Edwards Model 360 Evaporator; Grand Island, NY). Then the filter surface was viewed with an Autoscann SEM (Etec, Inc., Hayward, CA) as described below.

SEM/EDX Analysis of Glass Particles. Confirmation of particles as glass, undoubtedly arising from Eclipse glass fibers, was established using two different methods: (a) polarized microscopy (Ref. 19; see above); and (b) analytical scanning electron microscopy energy dispersive X-ray microanalysis (20). In the EDX analysis, we used an Hitachi S-800 field-emission SEM (Hitachi Scientific Instruments, Mountain View, CA) with an accelerating voltage of 25 kV. X-ray spectra were collected with a PGT X-ray microanalyzer probe (Princeton Gamma-Tech, Princeton, NJ). The X-ray spectra recorded for the suspect glass particles was compared with Eclipse-derived glass fibers. We have recently used this methodology for defining the elemental (chemical) composition of inhaled particles in human lungs (21).

Mechanical Smoking of Eclipse. The release of glass fibers from the filter of Eclipse articles was tested with a smoking machine. The smoking machine was constructed at the Roswell Park Cancer Institute (Electrical Bioengineering Instrumentation Center and Occupational and Environmental Safety). The machine was engineered to permit cigarettes to be smoked with preselected smoking conditions. The machine smoking parameters could be varied to approximate the smoking behavior of smokers (6). In these studies, the machine settings were as follows: (a) puff volume, 35 cc; (b) puff duration, 2.0 s; (c) puff vacuum, 10 mm H2O; (d) puff frequency, one every 60 s; and (e) total puffs per Eclipse, ~10.

The glass fiber release assay was performed in the following manner. The filter surface of an Eclipse was examined with a stereo-zoom microscope. X- and Y-coordinates were established by positioning four small marks with a black felt tip pen on the filter tipping paper. Then, for each filter surface, a map was drawn of the location and orientation of glass fibers that were observed with a stereo-zoom microscope. Thereafter, the Eclipse was positioned onto the smoking machine, ignited with a butane cigarette lighter, and smoked mechanically. After smoking, the filter surface was reexamined and compared with the original map. The displacement of one or more glass fibers was recorded as a positive test.

Results
Displaced and Protruding Glass Fibers Observed on Eclipse Article Tip. The two insulation mats of glass fibers on the tip of Eclipse are shown in Figs. 1 and 2. An on-end inspection of the tip revealed marked variation in the integrity of the glass mats; frequently, clusters of glass fibers were displaced (Fig. 2, a–c). In many instances, glass fibers was seen protruding from the insulation rolls (Fig. 2, a and b). Glass strands projecting outwardly from the mat were detectable with the naked eye and were visible readily with a hand-held magnifying glass. Greater definition of the glass rods extending randomly from the cut surface of the Eclipse tip was obtained with a stereo-zoom microscope (Fig. 2d).

An assay was performed to define the relative frequency of glass strands extending from the Eclipse tip. In this test, we evaluated Eclipse (n = 60) that had been obtained from three different Eclipse packs (A, Regular; B, Molds; and C, Menthol). Each Eclipse was placed on the stage of a stereo-zoom microscope and examined individually. The following scoring plan was used to categorize the number of glass fibers that extended 1 mm or more from the tip: group I (<5 fibers/Eclipse); group II (5–15); and group III (>15). Values recorded were as follows: group I: pack A = 1/20 Eclipse, B = 3/20, and C = 12/20; group II: A = 9/20, B = 11/20, and C = 5/20; and group III: A = 9/20, B = 3/20, and C = 1/20. Thus, 63% of the Eclipse (n = 38/60) displayed five or more glass fibers that protruded 1 mm or more from the tip.

Glass Fibers Observed on the Paper Wrappers of Eclipse Articles. Glass strands were observed on the white paper wrapper of the Eclipse articles, including the shaft and tip (Fig. 2d). No tests were performed to define the frequency with which glass fibers occurred on the white paper wrapping because we thought that it would be more informative to analyze the mouthpiece for glass fiber contamination.

Glass Fibers Seen on Cork-like Tipping Paper. An examination was undertaken to learn whether glass fibers were present on the cork-like mouthpiece. Of the 16 Eclipse articles that we examined, all tipping papers had been contaminated with glass strands. Included in this analysis were both Eclipse (n = 12) and NEW Eclipse (n = 4). Each Eclipse was from a different pack and had been collected randomly. The number of glass fibers on the tipping paper ranged from 5 to 44 (mean ± SE, 23 ± 2.4).

Charcoal particles, undoubtedly derived from the fuel rod, were also observed frequently on the tipping paper of Eclipse and NEW Eclipse. Also discovered on the tipping paper of Eclipse, NEW Eclipse, and Camel cigarettes were cellulose acetate particles and broken fibers.

In contrast, no glass fibers or charcoal particles were observed on the tipping papers of conventional filter cigarettes (Camel, RJR; n = 4). Likewise, no glass fibers were observed on the negative control slides (n = 4).

Glass Fibers Found in Eclipse Pack Residue. Having observed glass fibers protruding from the tip of Eclipse articles and present on both the white wrapping paper and cork-appearing tipping paper, we undertook a study to learn whether glass fibers were present in pack residue of Eclipse. For all Eclipse packs examined, numerous glass fibers were present in the pack residue (Fig. 2e). The glass fibers were differentiated effortlessly from the few other fiber types that were found in the residue and which included paper strands and cellulose acetate filter fibers. Glass fibers in the pack residue, however, were indistinguishable from the glass fibers of the mats at the tip of the Eclipse.

Glass material in the pack was morphologically heterogeneous. Fibers were always observed and were of variable length. Remarkably long glass fibers (>200 μm) as well as short fibers were observed in all packs. Glass that was recognized as components of the shattered glass fibers was present...
The average number of glass fibers present in an Eclipse pack (98%) of the Eclipse filters discount cigarettes packs of each of the three styles). Conventional premium and assay of Eclipse (Regular, Milds, and Menthol; six 20-count the pack residue. In greater detail below, the glass fibers observed on the filter were not observed in the residue of packs (n = 7) of conventional cigarettes.

A coating, probably a glass fiber binding agent (10), was observed on the surface of some of the glass fibers. Glass fibers from both the Eclipse tip and pack residue contained the coating. The glass fiber bonding agent was seen with conventional white light and polarizing microscopes, and its presence on Eclipse glass fibers could be examined critically on the high-resolution afforded by a SEM (see below).

**Glass Fibers Discovered on Eclipse Filter.** The discovery of binder-coated glass fibers in the pack residue suggested to us that the glass fibers, particles, and dust may have originated from the insulation mats at the tip of the Eclipse. This observation prompted us to inquire as to whether the glass fibers and particles from the insulation mats had moved onto the face of the Eclipse filter. To this end, examinations were performed to ascertain whether glass fibers, particles, and fragments were present at the mouth end of the Eclipse cellulose acetate filter. Our inquiry revealed that glass fibers were observed easily and routinely on the Eclipse filter. Moreover, as will be described in greater detail below, the glass fibers observed on the filter were indistinguishable by SEM and SEM/EDX from glass fibers in the pack residue.

Our findings were documented further in a comparative assay of Eclipse (Regular, Milds, and Menthol; six 20-count packs of each of the three styles). Conventional premium and discount cigarettes (n = 10 packs) were used as controls. Most all (98%) of the Eclipse filters (n = 352/360) were corrupted with glass fibers (Fig. 3). Values recorded for each of the different Eclipse styles were: Regular, 95.0% (n = 114/120); Milds, 98.3% (n = 118/120); and Menthol, 100% (n = 120/120).

Glass fibers were discovered also on the filters of Eclipse that had been obtained from other countries (Hi-Q and Inside). Similarly, the filters of Premier were also contaminated with glass fibers.

More recently, RJR introduced Eclipse with a new filter design. We included these NEW Eclipse into our studies to determine whether the defect of glass fiber contamination of the filter had been corrected. Almost all of the NEW Eclipse articles examined had filters with glass fiber contaminants. In our assay of 120 NEW Eclipse, all but 1 (n = 119/120; 99.2%) were contaminated with glass fibers (Fig. 3).

Conventional cigarettes were also analyzed for glass contaminants. Cigarettes assayed included: Winston and Doral (RJR); Marlboro and Basic (Philip Morris, Inc.); Kool and GPC (Brown and Williamson); L&M and Lark (Liggett Group); and Newport and Kent (Lorillard). Of the 10 packs examined, glass fibers were never observed on the filters of conventional cigarettes.

Similarly, the filters of Premier were also contaminated with glass fibers.

The contamination of Eclipse, Hi-Q, Inside, and NEW Eclipse with glass fibers was commonplace, extensive, and global. Furthermore, test results of Premier illustrate that glass fiber contamination of the filter had persisted for years.

**Glass Fibers on Eclipse Filters Identified with a Fiber Transfer Test.** Glass fiber contamination of the Eclipse filter was corroborated further in the fiber transfer test (see "Materials and Methods"). In this test, we analyzed the filters of eight Eclipse from each of three randomly selected packs. Of the 24 Eclipse filters analyzed, all were contaminated with glass fibers; two-thirds (n = 16/24) had 20 or more fibers (Fig. 4). The number of glass fibers harvested ranged from 5 to 55 per
electron microscopy observations, it is a common practice to
Eclipse filters were examined with a SEM. For all light and
could be released readily was obtained in a serendipitous ob-
servation made in studies in which the Eclipse and NEW
unabated and readily during smoking.

It would be reasonable to predict that they would be released
plasticizer
glass fibers on the filter surface were affixed, connected,
critical examinations, we failed to detect any evidence that the
glass particles on Eclipse and NEW Eclipse filters was obtained
resolution viewing of the glass contaminants of Eclipse and
Eclipse filters was achieved with a scanning electron
NEW
Eclipse filters is illustrated (glass fi-
Eclipse and 6). Detailed viewing of glass fibers and
glass particles on Eclipse and NEW Eclipse filters was obtained
two morphological features that were
fibers and cellulose acetate fibers of the Eclipse filter are
 Investigators
some glass fibers present on each of the 24
Fig. 5a). Notable was the frequent appearance of glass fibers
fibers were hidden deep within the cellulose acetate bundle
Not illustrated
the filters of 24 conventional ciga-
glass fibers were never observed on
using the same assay procedure,
glass fibers were never observed on
the filters of 24 conventional ciga-
-Eclipse filter (mean ± SE = 26.2 ± 2.6; Fig. 4). In the same

Glass Fibers on Eclipse Filter Revealed by SEM. High-
resolution viewing of the glass contaminants of Eclipse and
NEW Eclipse filters was achieved with a scanning electron
microscope (Figs. 5 and 6). Detailed viewing of glass fibers and
glass particles on Eclipse and NEW Eclipse filters was obtained
easily and frequently. Two morphological features that were
particular useful in distinguishing microscopically the glass
fibers and cellulose acetate fibers of the Eclipse filter are
illustrated in Figs. 5, a and b: (a) the glass fiber had a rod-shape,
whereas the cellulose acetate fiber had a distinct Y-shape; and
(b) the size of the cellulose acetate fiber was invariably larger
than that of the glass fiber.

The position and orientation of the glass fibers on the filter
surface varied markedly. Most of the glass fibers were observed
lying upon the filter surface (Fig. 5, a and d). Some glass rods,
made randomly and viewed at a relatively low magnification of
12,500. Having identified a glass fiber, a photograph was
viewed at a high power. However, "charging" occurred often,
and this release of electrons caused the glass fiber to jump from
the field of view. In some instances, the glass fiber was ob-
served on another position on the filter; in other cases, it could
not be found. The displacement and release of the glass fiber
was due to an excess charge injected by the electron beam that
could not flow to ground. The build up of charge in the
cellulose acetate fibers and the glass fibers repelled the two
fiber types, resulting in the ejection of the glass fibers from the
electron-enriched area. Recall, however, in all electron micros-
copy applications, the specimen (e.g., Eclipse filter) is viewed
in a sealed air-tight vacuum column positioned on a low-
vibration air-table. Thus, the displacement of the glass fiber was
cased by an electrical, and not mechanical, action.

Length and Diameter of Glass Fibers Defined by SEM. The
morphology and dimensions of the glass fibers and glass
particles were analyzed by SEM (Fig. 6). Long (>200 μm) and
short glass fibers were observed lying upon the surface of
cellulose acetate filter fibers (Fig. 5, c and d). Glass fiber
diameters were relatively uniform (∼5 μm; range, 4–6 μm).
For some glass fibers, the ends displayed sharp transverse
breaks, whereas other glass fibers displayed uneven, frag-
amented ends (Figs. 2f and 5a). The surface of the glass fiber was
relatively smooth. Fiber binder on the glass fibers was
prominent (Fig. 2f and 5a) and amorphous (Fig. 5, a and b).
Glass Fragments Identified by SEM/EDX. Glass rod frag-
ments and debris were observed by light microscopy in the pack
residue of Eclipse (Fig. 2e). SEM examination of the pack
residue showed that the observed particles, thought to be from
Eclipse Contaminated with Glass Fibers

Fig. 5. Glass fibers on Eclipse filter imaged with a SEM. Glass fibers on the Eclipse filter were seen frequently, readily, and in great detail with a SEM. All panels present views looking down onto the cut surface of an Eclipse filter face. These panels illustrate that the glass fibers were not bound to the plastic-like cellulose acetate filter fibers. Furthermore, the perspectives illustrate the ease with which the glass fibers would be released into the smoker's mouth. a, the surface of an Eclipse filter exhibiting three glass fibers (arrows). The glass fibers were distinguished promptly from the large Y-shaped cellulose acetate filter fiber (*). Binder or binder-like material (sharp arrow) is shown streaming from the surface of one of the glass fibers. Bar, 10.0 μm. b, glass fiber (length, ~135–140 μm), balanced on a curved, Y-shaped cellulose acetate filter fiber. This view illustrates further the ease with which glass fibers and cellulose acetate fibers were distinguished morphologically. Bar, 10 μm. c, single short glass fiber (arrow), standing freely on its broken end, on the surface of a cellulose acetate filter fiber. Bar, 1.0 μm. d, broken short glass fiber lying upon the surface of one of the three arms of a Y-shaped cellulose acetate filter fiber. Bar, 1.0 μm.

glass fiber breakage, were morphologically heterogeneous and included glass chips, specks, and dust. To substantiate unequivocally that these items were glass and not of other material, the chemical element composition of the particles was defined by SEM/EDX.

Fig. 6d shows a view of a single glass fiber and three adjacent particles that are morphologically dissimilar. The histograms of the elemental analysis of the glass fiber (Fig. 7) were compared with those of the suspect particles. The histogram of the fiber revealed a major peak of silicon and smaller peak of calcium (Fig. 7). The SEM/EDX profile of the glass chip (Fig. 7, inset) was indistinguishable from that of the fiber. These and other SEM/EDX profiles of fragments, particles, chips, and items ≤1.0 μm were authenticated as being of glass. We concluded, therefore, that these glass particles and fragments originated from fracture and breakage of the Eclipse glass fibers.

Glass Fibers Released from Eclipse Filter During Smoking. From our extensive examinations of Eclipse filters with a stereo-zoom microscope and SEM, we concluded that the number, size, position, orientation of the unbound glass fibers, fragments, and particles on the cellulose acetate filter surface would suggest that some of the glass items would be released into the smoker's mouth during smoking. Notwithstanding, tests were performed in which Eclipse articles were smoked mechanically to determine whether glass fibers were released during smoking. Positive results were recorded for 80% of the Eclipse articles studied (n = 12/15).

Noteworthy was that the comparison of the maps drawn for the glass fibers on the Eclipse filters before and after smoking often revealed the appearance of previously unidentified glass fibers. The newly discovered glass fibers were thought to have been drawn up from an undetected position, most likely deep within the colonnade of cellulose acetate fibers, to the filter surface during mechanical smoking.

Discussion
In studies reported herein, we have: (a) observed glass fibers and other glass contaminants lying freely on the cut surface of filter by light and electron microscopy; (b) failed to detect any evidence to suggest that these glass fibers were bound or glued to the filter surface with binding agents, plasticizers, or other materials; (c) discovered that the glass items were liberated from the filter by touching to tape. Inevitably the glass items would move easily from the cut surface of the filter to the smoker's lips and tongue; (d) shown that the glass fibers lying
Fig. 6. Glass fiber contamination of NEW Eclipse filter and SEM confirmation of glass particles. This figure illustrates glass fiber contamination of the customized filter of a NEW Eclipse and documents the presence of glass particles as originating from Eclipse glass fibers. a, a view with a stereo-zoom microscope of two glass fibers (arrows) that are observed easily as protruding toward the opaque, black-appearing, hollow central cavity of the cellulose acetate filter of a NEW Eclipse. The displaced glass fibers of the NEW Eclipse can be distinguished quickly, even in this low-power view, from the single, thick, curved cellulose acetate filter fiber that has been dislocated and is prominent between the two arrows; b, SEM view illustrating the heterogeneity in the size of the Eclipse-derived glass contaminants that range from elongated fibers to dust-like specks (bar, 60 μm); c, high-power view of a single glass particle. Arrow, a sharp fracture plane where this particle broke from a glass fiber. Binder or binder-like material is shown on all surfaces of the particle (bar, 1.0 μm); d, SEM view of a glass fiber (right side) and adjacent morphologically heterogeneous particles; confirmation that the three particles were glass was achieved by SEM/EDX (see Fig. 7; bar, 2 μm).

on the cut surface of the filter were moved by charging that occurred during SEM observations; and (e) glass fibers on the filter were displaced during mechanical smoking of Eclipse.

Corruption of the filter with glass fibers was documented in tests of Premier, Eclipse, NEW Eclipse, HiQ, and Inside. Thus, glass pollution of the filter of Eclipse was widespread, collective, and continuous. Experiments similar to those performed using Eclipse were also carried out on conventional cigarettes, and in no instance was even one glass fiber discovered.

The glass fibers observed on the filter, in the pack residue, and on the white wrapper paper and tipping paper of the Eclipse articles were optically and morphologically indistinguishable from the glass fibers of the insulation mats at the tip. Moreover, the glass particles were chemically indistinguishable from the glass fibers as defined by SEM/EDX.

The observed glass fibers and particles on the Eclipse filter were undoubtedly from the glass fiber insulation mats. We envision that the brittle and thin glass fibers of the mats were fractured and shattered during high-speed Eclipse manufacturing, particularly during the process in which the glass mats and carbon fuel rod are bisected transversely. In support of this perception is the observation that fragments of plastic fibers, such as cellulose acetate fibers, forming the mouthpieces of filter cigarettes tend to become separated from the filter mouthpieces during cutting and contaminate the area around the filter (Ref. 22; see also Refs. 16 and 38). Thus, the glass particles would be produced by cutting...
Eclipse. In addition, glass fibers would be shattered during subsequent operations, including rapid packaging and shipping. The glass debris attaches nonspecifically to all surfaces of the Eclipse articles. Most importantly, the glass fibers, particles, and fragments translocate to the cut surface of the mouthpiece, where they were found atop and entangled loosely within the carpet-like filter surface.

Eclipse is packaged standing on its tip. Thus, the glass fibers protruding from this end would be susceptible to breakage resulting from jostling that would occur during daily transport by the smoker, particularly if the Eclipse package was only partially filled. Furthermore, the likelihood of glass debris in the pack residue contacting and adhering to the cut filter face would be greatly increased. Studies reported herein were conducted using Eclipse from freshly opened packs. We would anticipate, therefore, finding a larger number of glass fibers, particles, and fragments on the filters of Eclipse articles of in-use packs.

Eclipse has been viewed favorably by some who perceive it as a smokeless cigarette that yields relatively low amounts of tar, nicotine, and ash (4, 5, 7, 13). It has been argued that Eclipse provides an alternative smoking article for health-conscious smokers who are: (a) unwilling to abstain from smoking; (b) nicotine-addicted and are unable to quit; and/or (c) concerned with the health risks of passive smoke and who wish to reduce the exposure of smoke to children, family members, and others (1–3, 4, 6, 7, 9–14).

In contrast, some reviewers have asserted that Eclipse is not a cigarette, and that Eclipse should be classified as a nicotine delivery device (5, 11). Others have perceived Eclipse as a ploy to challenge clear-air regulations banning cigarette smoking in designated areas (4, 7). Some analysts who have studied Eclipse believe that a nicotine-addicted smoker will accept these drawbacks and use a less favorable, smokeless, nicotine-dispensing smoking article in a restricted clear-air environment until a full-flavor conventional cigarette can be smoked in an unrestricted area (4, 7, 11).

Accordingly, the goals for Eclipse declared by RJR, the perception by others of RJR motives, and the anticipated use of Eclipse have varied markedly. Likewise, the health benefits to be realized by the Eclipse and NEW Eclipse user have been the subject of debate (4, 7, 9, 11, 14). Regardless of the intent, RJR has spent a considerable amount of time and money on Eclipse during a time when their share of a highly competitive market has declined (14).

A leaflet that accompanies each pack of Eclipse instructs the smoker to “take an extra puff and a longer draw while holding a flame to the carbon tip.” The increased vigor of puffing would increase further the probability that glass fibers, particles, and fragments would be discharged into the smoker’s mouth during smoking. In an apparent attempt to correct the hard draw, the mouthpiece of the NEW Eclipse was redesigned. It consists of a filter-appearing rod (diameter, \(\sim 7 \text{ mm}\)) having a central longitudinal passageway. This tunnel (diameter, \(\sim 4 \text{ mm}\)) spans the truncated filter rod (length, \(\sim 9 \text{ mm}\)). Thus, the short hollow mouthpiece of the NEW Eclipse, shown in Fig. 6a,
is thought to achieve little or no filtration of the smoke, including both the tar and vapor-phase components. When viewed on-end, glass strands were seen readily protruding from the white cellulose acetate bundle into the central, black-appearing tunnel (Fig. 6a).

RJR has not revealed to the Eclipse smoker the use of glass fibers. Known Eclipse smokers included thousands of individuals who were paid participants of test panels that were assembled in different cities. Today, Eclipse articles are available on the open market and are being smoked by people in different countries (United States, Germany, Sweden, and Japan; Refs. 1, 2d, 14). RJR did not disclose to the consumer the presence of glass fibers in Eclipse in: (a) a package warning label; (b) an instructional brochure that was included in each pack; (c) promotional video tapes; or (d) newspaper advertisements.

The health risks and hazards associated with glass fibers in RJR’s Premier and/or Eclipse smoking articles have been addressed specifically in two documents. The first document is a U.S. patent, filed in 1992 and awarded in 1994, to inventors Serrano et al. (23) and assigned to Philip Morris, Inc. The Philip Morris patent describes the construction of a smoking article delivering a nicotine-containing flavored aerosol rather than conventional tobacco smoke. This invention relates to: “... a smoking article in which the sensations associated with the smoking of tobacco are achieved without the burning of the tobacco.” The aerosol is generated by a convective and radiative heat transfer from a burning pure carbon rod. A claim is made that the article generates substantially no sidestream smoke. The intent, as well as some design features, are similar to RJR’s prototypes (7), Premier and Eclipse (2, 3, 5, 6).

In presenting the background of their invention (23), Philip Morris makes reference to a U.S. patent assigned seven years previously to RJR for an Eclipse-like smoking article (26). Philip Morris argues that the RJR device: “... suffers from a number of drawbacks. First, the resilient glass fiber insulating jacket is difficult to handle on modern mass production machinery without special equipment. Second, the glass fibers may become dislodged during shipping and migrate through the pack to rest on the mouth end of the article, giving rise to the potential for the inhalation of glass fibers into the smoker’s mouth” (23). In an additional warning, Philip Morris claims: “It is a further objective of this invention to avoid the potential for inhalation of glass fibers by a smoker of such an article” (23).

The second document was a lawsuit filed against RJR for using glass fibers in their new cigarettes (27). The litigation against RJR was filed in March 1995 by Schuller International, Inc. In this action, Schuller sought to bar its glass fibers from being used in: “the manufacture of a new cigarette product for sale to the public” (27). In the summer of 1993, RJR asked Schuller to supply between 20,000 and 50,000 pounds of “C” glass fiber to RJR by December 1993 (27). “C” glass fiber had a higher heat tolerance than “T” glass fibers. The “T” glass fibers that had been supplied previously had been shown to fuse in the smoking article during testing (27). Schuller claimed that: “... all purchases of ‘C’ glass fiber by RJR were understood by both parties to be used only for developmental purposes and not for commercial production of a new cigarette product” (27).

Arguments were also presented in the lawsuit to provide indemnification of Schuller by RJR (27–29). These arguments related to a draft of a “Specialty Supplier Agreement” for the sale of glass fibers (27). The draft contained a provision providing that Schuller would: “... defend, indemnify and hold harmless [RJR]. . . . against all claims, damages, losses and expenses . . . attributable to . . . (a) bodily injury, or death . . .” (27).

The lawsuit further declares that: “Schuller and RJR have never resolved either Schuller’s policy concerns or the scope of indemnification or other contractual protections that RJR would provide Schuller in the event that the two companies could establish a continuing business relationship” (27). Schuller withdrew the case on May 5, 1995 after reaching a settlement with RJR (30, 31). The terms of the accord were not disclosed other than Schuller would no longer supply RJR with glass fibers (31).

The association of fibrous glass and cancer has been addressed in a document authored by investigators from the Environmental Carcinogenesis Program of the National Institutes of Environmental Health Sciences, Duke University Medical Center, and the Occupational Safety and Health Administration of the United States Department of Labor (17). These examining declared “that fibrous glass materials are carcinogenic . . .” (17). This assessment included an analysis of data from both laboratory experiments (e.g., animal studies) and epidemiological studies (human data; Ref. 17). Furthermore, they concluded: “... that on a fiber-per-fiber basis, glass fibers may be as potent or even more potent than asbestos” (17). Letters presenting opposing view points have been presented (32–34). These letters were followed by a concluding response and rebuttal (35). RJR has discussed their perception of the potential toxicity associated with the use of the glass mat in the Premier- and Eclipse-like “NEW CIGARETTE” prototypes (10). No results or discussions, however, were presented for RJR’s proposed analysis of “glass fibers” in “mainstream smoke” (Table 3.4.3–1 in Ref. 10) or subsequent RJR publications.

Health risks of fibrous glass (i.e., glasswool; respirable size) have been reviewed also by the NTP of the United States Department of Health and Human Services. For many years they have and continue to assign glasswool in a category for a “substance or group of substances and medical treatments which may reasonably be anticipated to be a carcinogen” (Ref. 36; see also Ref. 17). Other agents listed in this grouping include: (a) ceramic fibers (respirable size); (b) PAHs [n = 15; e.g., benzo(a)pyrene]; (c) dioxane; (d) polychlorinated biophenyls; and (e) 1,1-bis(p-cholorophenyl)-2,2,2-trichloroethane (DDT; Ref. 36). The NTP notes further that “there is sufficient evidence for the carcinogenicity of glasswool in experimental animals” (17).

Inhaled glass fibers (37) and glass dust (38) have been isolated from the lungs of affected patients with lung disease, and the glass material was identified unequivocally by SEM/EDX (37).

In January 1998, the NTP upgraded crystalline silica (respirable size; e.g., quartz; Ref. 39) to that of a “known human
carcinogen.” Glass fibers and microparticulates, as is known for crystalline silica, may induce inflammation, fibrosis, hyperplasia, or other nonmalignant pulmonary diseases (17, 36–39).

We (16, 40, 41) and others (42, 43) have documented the discharge of different types of foreign bodies from cigarette filters, including cellulose acetate filter fibers (16, 40, 41), asbestos fibers (43), and carbon from cigarettes with charcoal filters (40, 42), cigarette paper fibers (42), crystalline materials (“cellulose acetate additives”; Ref. 42), and unidentified particles (42). In studies in which conventional cigarettes were smoked mechanically, crystalline material and filter material additives were released (42); the size of these particles were within the submicron range (1/20 to 1/40 μm; Ref. 42). The release of various fibers and particles from cigarette filters was documented with a transmission electron microscope in studies funded by the Brown and Williamson Tobacco Company (42). These comprehensive scientific findings were presented in a 109-page monograph that was published ~40 years ago (42). Philip Morris, Inc. has known and tested routinely, beginning as early as the 1970s, cigarette filters for the “fallout” of cellulose acetate fibers (44) and charcoal (45).

Today’s smoker is unaware that cigarette filter elements of different origin and size are being released into their mouths during smoking. These consumers are uninformed that tar- and toxin-coated biopersistent filter components will be inhaled and/or ingested during normal smoking behavior. Battery by these filter elements is not part of the smoking experience.

Today, both conventional and nonconventional smoking articles are being marketed as having a greater consumer benefit, including reduced health risks and decreased environmental smoke. Paradoxically, the filter was designed to absorb and trap tar in cigarette smoke. Tobacco tar binds rapidly and tenaciously to most all surfaces (e.g., glass, plastic, cotton, and paper). The binding of tobacco tar to glass fibers used in prototype cigarette filters has been known for many years. Likewise, the use of glass fiber filters (e.g., Cambridge filters, Ref. 15) in smoking machines, for the quantitative assessment of tar, as well as glass flasks, used for the condensation of tobacco smoke for extracting different tar components, is known widely (see also Ref. 46). Furthermore, it is widely accepted that the adsorption of tobacco tar onto glass fibers is nonspecific, efficient, and rapid (47–49). In this context, we have observed that tobacco tar binds to the Eclipse glass fibers.

The enhanced health hazard associated with cigarette smoking and fiber/dust inhalation has been discussed by many scientists. The synergistic effects of tobacco smoking and inhaled asbestos have been well documented. We hold the opinion that an increased health risk may arise from the inhalation of tar-coated glass and/or cellulose acetate fibers and particles. Support for this expectation is derived from studies similar to that reported herein. For example, the adsorption of PAHs, from tobacco smoke, onto asbestos fibers has been postulated for the known synergistic effect of cigarette smoke and asbestos (48, 49). This “PAH carrier hypothesis” proposes that asbestos fibers carry PAH into the cells and influence their metabolism. An alternative hypothesis predicts that the fiber acts as a complete carcinogen when it is chronically retained in the bronchial wall (49). In this “fiber implantation hypothesis,” the irritants and toxins contained in tobacco smoke serve as efficient cocarcinogens by damaging the bronchial mucosa and impairing the bronchial clearance mechanisms (49). A similar opinion was expressed by Farr and Revere (42) in 1958 in describing their observation of the discharge of particles from cigarette filters: “In view of the accumulated medical evidence concerning the greater irritation to the respiratory tract from a solid particle with a coating of hydrocarbon than from either the particle or hydrocarbon alone, the need to eliminate solid particulate material from the smoke streams would seem to be indicated.”

Eclipse-derived glass released into the smoker’s mouth may also become entrapped in the saliva and, subsequently, swallowed. Thus, some of the glass fibers and glass microparticulates are likely to be ingested. Accordingly, the mouth, respiratory tract, and digestive system are at risk to toxin-coated bioreistant glass discharged from Eclipse. In this context, glass in foods is recognized by the Food and Drug Administrations as extraneous matter for which there is zero tolerance.

Our studies have documented glass fiber contamination of the filter and substrantiates with reasonable certainty that glass fibers would be inhaled and/or ingested when Eclipse is smoked as intended. These findings and known risks associated with glass fibers delineate and designate Eclipse as a defective product.

The filter of conventional cigarettes is perceived as both efficient and safe. However, the American Thoracic Society, the Medical Section of the American Lung Association, adopted in 1995 this official statement: “Epidemiological studies have shown that brands of cigarettes that contain less tar and nicotine only marginally reduce the risk of lung cancer mortality. Similarly, little difference in mortality has been found for lifelong filter versus nonfilter smokers and for persistent smokers who switch from nonfilter to filter cigarettes” (50).

Many U.S. patents are being awarded yearly to tobacco companies for technically complex multiple component cigarettes consisting of tobacco-like material with assorted chemical additives (1, 4). Some will be promoted as safer cigarettes with lower health risks (23). Other low-smoke, nicotine-delivery devices, also having the appearance of cigarettes, will be introduced to avoid clean-air ordinances (4).

Cancer prevention, particularly smoking cessation, will continue to be a primary goal of health organizations throughout the world. There exists, however, no regulatory body that provides an independent analysis of cigarettes. Unlike the products of the food, drug, and cosmetic industries, smoking articles and chewing tobacco of the tobacco industry remain unregulated. Thus, the question posed to the medical, scientific, and public health communities remains unanswered as to who will define the health risks imposed on the nicotine-addicted, unformed smokers who participate in worldwide market tests of experimental tobacco articles.

We believe that smokers have the right to be educated fully of all and all health hazards and risks associated with particular brands of cigarettes that are offered for sale. RJR has promoted Eclipse as a “great-tasting cigarette with less secondhand smoke, no ashes, no lingering odor, and practically no staining on walls, windows, and curtains” (RJR’s promotional video). It is what RJR has failed to tell consumers about Eclipse that concerns us. Contamination of Eclipse filters with glass fibers and glass dust may pose an additional health risk to the smoker. Eclipse is a paradigm of the health danger that may be imposed by technically complex tobacco articles and nicotine delivery devices promoted by an unregulated industry preying upon addicted smokers who seek a less hazardous cigarette.

* NTP, 9th Report on Carcinogens (Attachment 3), January 1998. Also see IARC Classification Group 1: "carcinogenic to humans."
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