Cigarettes with defective filters marketed for 40 years: what Philip Morris never told smokers

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Background: More than 90% of the cigarettes sold worldwide have a filter. Nearly all filters consist of a rod of numerous (>12,000) plastic-like cellulose acetate fibres. During high speed cigarette manufacturing procedures, fragments of cellulose acetate that form the mouthpiece of a filter rod become separated from the filter at the end face. The cut surface of the filter of nearly all cigarettes has these fragments. In smoking a cigarette in the usual manner, some of these fragments are released during puffing. In addition to the cellulose acetate fragments, carbon particles are released also from some cigarette brands that have a charcoal filter. Cigarettes with filters that release cellulose acetate or carbon particles during normal smoking conditions are defective.

Methods: Document searches utilised databases of the scientific literature, medical journals, chemical abstracts, US Patents, Tobacco Abstracts, papers presented at tobacco meetings and court documents.

Results: Sixty one documents of Philip Morris, Inc were selected for study because they disclosed specifically the “fall-out” of cellulose acetate filter fibres and, for cigarettes with charcoal filters, carbon particles from cigarette filters. The term “fall-out” was defined in 1985 laboratory protocols of Philip Morris, Inc as “loose fibers (or particles) that are drawn out of the filter during puffing of the cigarette”. As early as 1957, the health concern of inhaling cellulose acetate fibres released from cigarette filters was addressed by Philip Morris, Inc. A 1962 document reported the results of laboratory tests conducted by Philip Morris, Inc that compared the “fall-out” of cellulose acetate fibres from the filters of their cigarettes (Marlboro) and cigarettes of their competitor (Liggett & Meyers). A 1997 overview by Philip Morris of documents addressing the “fallout of carbon particles and cellulose acetate fibers from filters” stated that they were “essentially routine reports” of cigarette filter assays, and referenced a “Filter Fallout” memo written in 1961—more than 40 years ago. Most likely these tests are being conducted presently as illustrated by a 1999 report that details the revisions of the “fall-out” protocol of Phillip Morris, Inc and reports the results of tests that measured the discharge of cellulose acetate fibres and silica gel from beta cigarettes with a new type of filter. Our analysis of the “fall-out” tests results presented in the 61 “fall-out” documents showed that filter fibres and carbon particles were discharged from the filters of all types of cigarettes tested. These cigarette types (n = 130) included both coded cigarettes and popular brand name cigarettes. No publications were found in the scientific literature of the “fall-out” studies. Thus, the results of the “fall-out” studies are thought to have been withheld as confidential to Philip Morris, Inc. We have identified also other companies that have tested recently cigarettes for defective filters. In addition, our searches have shown that simple, expedient, and inexpensive technologies for decontaminating cigarette filters of loose cellulose acetate fibres and particles from the cut surface of the filter have been developed and described in 1997 and 1998 US patents. What is more important is that these patents also define methods for preventing or reducing the broken plastic-like fibres that arise during cigarette making. Many US patents (n = 607; 1957 to 2001) have been awarded for cigarette filters. Some of these inventions describe novel materials and unique filtration schemes that would eliminate or minimise the discharge of filter materials into mainstream smoke.

Conclusions: We have shown that: (a) the filter of today’s cigarette is defective; (b) Philip Morris, Inc has known of this filter defect for more than 40 years; (c) the existence of this filter defect has been confirmed by others in independent studies; (d) many methods exist to prevent and correct the filter defect, but have not been implemented; and (e) results of investigations substantiating defective filters have been concealed from the smoker and the health community. The tobacco industry has been negligent in not performing toxicological examinations and other studies to assess the human health risks associated with regularly ingesting and inhaling non-degradable, toxin coated cellulose acetate fragments and carbon microparticles and possibly other components that are released from conventional cigarette filters during normal smoking. The rationale for harm assessment is supported by the results of consumer surveys that have shown that the ingestion or inhalation of cigarette filter fibres are a health concern to nearly all smokers.
Cigarettes marketed today may be perceived as having essentially two sections—a column of tobacco and a filter. Filters are present on more than 95% of the cigarettes sold today in the USA and more than 90% of the cigarettes sold worldwide. Thus, the filter is an integral component of most cigarettes.

Historically, filters were introduced to provide a cigarette mouthpiece that would prevent the release of tobacco flakes into the smoker's mouth. In 1950, cigarettes with filters commanded but 1% of the market. Thereafter, filter cigarettes gained popularity. In 1964, the US Surgeon General announced that cigarette smoking is causally related to lung cancer in men. At about that time, the majority of cigarettes had filters (64%, 1995). In 1986, 95% of the cigarettes made in the US had filters.1 (table 1).

Viewing the white face of the cigarette filter with the naked eye and compression of the filter column with the fingers would suggest that the filter is made of a sponge-like material. However, opening the cigarette filter, by cutting it lengthwise with a razor, reveals that it consists of a fibrous mass. Spreading apart the matrix reveals some of the more than 12 000 white fibres. Microscopically, these fibres are Y shaped and contain the delustrant titanium dioxide. The fibres are made of cellulose acetate, a synthetic plastic-like substance used commonly for photographic films. A plasticiser, triacetin (glycerol triacetate), is applied to bond the fibres.

The speed at which cigarette are made challenges the imagination—a single machine makes filter cigarettes at the rate of 15 000 or more per minute. This figure of 15 000 filter cigarettes per minute may be expressed also as 250 cigarettes per second; this is the equivalent of 50 cartons every 40 seconds. Likewise, cigarettes are boxed rapidly—approximately 450 packs per minute. State-of-the-art production plants of major tobacco companies operate around the clock with multiple cigarette making and packing machines to produce millions of cigarettes daily.4

During the high speed multi-step cigarette manufacturing procedures, cellulose acetate filter fragments break from the filter. Moreover, charcoal granules are released from cigarettes with certain types of charcoal filters. With a hand held magnifying glass, some of these black specks of charcoal are visible on the white filter face (table 1).

The definition of a defective filter has been presented previously. Specifically, in 1996 it has been established that for cigarettes with non-defective filters: “no charcoal particle enters the mouth of a smoker when he or she smokes.” In contrast: “A defective filter cigarette to whose filter end face charcoal particles are exposed, or through which charcoal particles are seen must be removed from the manufacturing line.” Accordingly: “a filter cigarette with a defective filter end face must be excluded because it is a defective product.”5

Likewise, we know that: “fragments of plastic fibers, such as cellulose acetate fibers, forming part of mouthpieces of filter cigarettes or like rod-shaped smokers' products tend to become separated from the respective filter mouthpieces at the end faces which develop in response to the making of cuts across filter filaments of sections of double unit length between pairs of plain cigarettes to obtain filter cigarettes of unit length.” It is emphasised that: “The fiber contamination of the mouthpiece occurs in spite of the partial bonding of the neighboring fibres to each other by resorting to suitable plasticizers.” These quotations are from 1997 and 1998 US patents awarded to Hauni Maschinenbau AG.11 Hauni AG, with its eight divisions of companies, has an established reputation as the world’s top manufacturer of high speed machinery for making, packaging, and analysing cigarettes.

Cigarettes have defective filters if cellulose acetate filter fragments are released from the filter by puffing. In 1995, an executive directive declared that tobacco companies: “are well advised to strongly urge filter manufacturers to explore ways of producing fiber-free filters. Cellulose acetate fibers, in the smallest concentrations, must not be found in lungs. This is true even if there is little likelihood for their contributing to the formation of lung cancer and to disease type inflammatory changes.”15

These observations and writings from independent investigators have prompted us to undertake the studies reported herein. In these studies, we tested the hypothesis that different tobacco companies have known of defective cigarette filters for many years. Moreover, it is theorised that tobacco companies, alarmed by the potential human health risks, in addition to those known to be associated with cigarette smoke, have concealed their findings of defective filters from scientists and smokers.

MATERIALS AND METHODS

Study goals

The goals of this study were to review systematically the writings of the tobacco companies to: (a) establish if different tobacco companies knew about the filter defect; (b) document when the defect became known to the tobacco industry; (c) assess the prevalence of the filter defect on cigarettes manufactured by different companies; (d) define whether the knowledge of the defect had been withheld by the tobacco company as confidential, and not disclosed publicly; (e) determine whether the defect exists for cigarettes marketed today, and (f) ascertain the feasibility of correcting or preventing the identified defect.

Methods

Writings of the tobacco companies addressing defective filters were searched using popular databases, including: Medline, Chemical Abstracts, US patents (IBM Intellectual Property Network and Delphion), and court documents. Court documents included those that were among the estimated 33 million pages of tobacco industry documents that are now accessible through worldwide websites. Full text searches were performed for documents on different websites, including: (a) tobacco documents at www.tobaccocontrol.org that incorporates the following document sources: American Tobacco Company, Brown & Williamson Tobacco Company, Council for Tobacco Research, Lorillard, Philip Morris, Inc, RJ Reynolds Tobacco Co, Tobacco Institute, new Lorillard, new Tobacco Institute, Philip Morris Advertisements, Bilette documents, Health Canada, Minnesota State Trial, and Roswell Park Cancer Institute; (b) tobacco industry documents from the US Centers for Disease Control at www.cdc.gov that incorporates the following document sources: Guildford—British American Tobacco documents, Minnesota Tobacco Document Depository; and other depositories that are listed at this website; (c) tobacco document websites of different tobacco companies (for example, Philip Morris, Inc at www.pmdocs.com); and (d) documents from the court case of David Tijerina et al v Philip Morris, Inc, and Hoechst Celanese Corp (defendants). Some of the documents from the Tijerina case were provided to one of the authors (JLP) who served as an expert witness. Written approval for the use of the documents from the Tijerina case for this report was obtained from the trial attorneys.

A manual search was performed of the: (a) “Table of contents” and “Index” for all volumes (volumes 11–26) of Tobacco Abstracts published from 1967 to 1982 (n = 33 588 abstracts), and (b) papers presented at annual congress of the Centre de Co-operation Pour Les Rescheres Science Relatives Au Tabac (CORESTA) from 1964 to 2000 (37 volumes), and from 17 special issues from different CORESTA symposia.

RESULTS

Literature searches for defective filters

Documents addressing cigarette filters were retrieved from different databases. A collection of Philip Morris, Inc...
## Table 1: Chronology of events related to the marketing of cigarettes filters in the USA, and filter fibre and carbon particle “fall-out” assays of Phillip Morris, Inc

<table>
<thead>
<tr>
<th>Date</th>
<th>Milestones and documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1863</td>
<td>From 1860 to 1920, cigarette filters were used to keep tobacco particles from entering the mouth.</td>
</tr>
<tr>
<td>1917</td>
<td>Cigarette filters introduced with charcoal powder, cotton wool, flax, hemp, cloth or coarse paper.</td>
</tr>
<tr>
<td>1924</td>
<td>Tobacco filters made by combining crepe paper and cellulose wadding.</td>
</tr>
<tr>
<td>1931</td>
<td>Parliament cigarettes (Benson &amp; Hedges) — first major filter tip cigarettes in USA.</td>
</tr>
<tr>
<td>1949</td>
<td>“Golden Throat” filter introduced by Rothmans, Int—cotton wool with crepe paper.</td>
</tr>
<tr>
<td>1950</td>
<td>Until the 1950s, “tipped” filter cigarettes were felt to be a novelty item directly mainly at the women’s market.</td>
</tr>
<tr>
<td>1951</td>
<td>Cigarettes with cellulose acetate filters introduced (1% market share), non-filter cigarettes (99% market share).</td>
</tr>
<tr>
<td>1959</td>
<td>Parliament cigarettes with recessed filter introduced by Philip Morris, Inc.</td>
</tr>
<tr>
<td>1959</td>
<td>Food and Drug Research Laboratories report results to studies contracted by Phillip Morris, Inc to examine five leading brands (Kent L&amp;M, Marlboro, Salem and Winston) of filter tipped cigarettes for the purpose of evaluating, quantitatively, the relative amounts of this particulate material which could be aspirated from the filters under conditions simulating normal smoking.</td>
</tr>
<tr>
<td>1959</td>
<td>Revised protocols for filter fibre fall-out (Method S-42) and carbon particle fall-out (Method S-43) written by Philip Morris, Inc.</td>
</tr>
<tr>
<td>1960</td>
<td>Almost all cigarettes sold have filters (93% market share, non-filter cigarettes, 7% market share).</td>
</tr>
<tr>
<td>1961</td>
<td>Parliament “Filter fiber fall-out” studies initiated to count and size cellulose acetate fibres released during smoking.</td>
</tr>
<tr>
<td>1969</td>
<td>Cigarette filters made by combining crepe paper and cellulose wadding.</td>
</tr>
<tr>
<td>1970</td>
<td>Cigarette filters made by combining crepe paper and cellulose wadding.</td>
</tr>
<tr>
<td>1972</td>
<td>Cigarette filters made by combining crepe paper and cellulose wadding.</td>
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<tr>
<td>1975</td>
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<tr>
<td>1984</td>
<td>Cigarette filters made by combining crepe paper and cellulose wadding.</td>
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<tr>
<td>1987</td>
<td>Cigarette filters made by combining crepe paper and cellulose wadding.</td>
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<td>1990</td>
<td>Cigarette filters made by combining crepe paper and cellulose wadding.</td>
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<td>1994</td>
<td>Cigarette filters made by combining crepe paper and cellulose wadding.</td>
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<tr>
<td>1998</td>
<td>Cigarette filters made by combining crepe paper and cellulose wadding.</td>
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<tr>
<td>2000</td>
<td>Cigarette filters made by combining crepe paper and cellulose wadding.</td>
</tr>
</tbody>
</table>
documents was culled out that addressed the release of different substances from the cigarette filter. These documents are referenced chronologically.

**Philip Morris filter “fall-out” documents**

Of the papers identified in our literature search, 61 were identified as unique in that they were documents of Philip Morris, Inc that addressed the “fall-out” or “fallout” of filter fibres and carbon particles from the cigarette filter. The term “fall-out” or “fallout” appeared in all 61 documents. Further, one of these two terms appeared in 85% of the document titles (52/61). The term “fall-out” was used in the title and text of the “FILTER FIBER FALL-OUT” protocol and “CARBON PARTICLE FALL-OUT” protocol of Philip Morris, Inc. We therefore designated this collection of 61 papers as the “Philip Morris Filter fall-out documents”, and selected them for study.

All 61 papers were typed reports. Most were written on Philip Morris, Inc stationary as an interoffice correspondence (n = 44/61; 72%). The majority (n = 51/61; 84%) of these memos were one page long. The largest document was 11 pages. All documents were stamped with at least one Bates number. Some had more than one Bates number. Identical documents sometimes had different Bates numbers. Some documents were stamped also with what is thought to be a central file code number of Phillip Morris, Inc (for example, C70-022269).

Searches were made of these documents to identify named individuals and their employment position, cigarette brands smoked, frequency and number of fibres and particles released in the tests, additional laboratory protocols, toxicology studies, and assessments of human health risks.

The first document of Phillip Morris, Inc that addressed human health risks associated with the inhalation of filter fibres was written in 1957 to the president, OP McComas. The letter “fall-out” was defined in the text of the “FILTER FIBER FALL-OUT” protocol to describe the equipment and procedures used for assaying the “fall-out” of fibres from cigarette filters. The term “fall-out” was defined as: “Loose particles that are drawn out of the filter during puffing and collected on filter media are called carbon particle “fall-out”.

Of this collection of 61 documents, most were written in 1983 (n = 11 documents). Many documents were from adjacent years (1982, n = 8 documents; 1984, n = 9 documents). The purpose of all the memos was to report the results of tests measuring the “fall-out” of filter fibres and carbon granules. Two laboratory protocols and selected “fall-out” assay results for both cellulose acetate fibres and carbon particles are described below.

**Measurement of filter fibre “fall-out”**

A 1985 report entitled: “Filter fibre fall-out,” authored by Nancy R Ryan, identifies “Method No. S-42” which is a protocol that describes the equipment and procedures used for assaying the “fall-out” of fibres from cigarette filters. The term “fall-out” was defined in the title and text of the “FILTER FIBER FALL-OUT” protocol to describe the equipment and procedures used for assaying the “fall-out” of fibres from cigarette filters. The term “fall-out” was defined as: “Loose particles that are drawn out of the filter during puffing of the cigarette and collected on filter media are called carbon particle “fall-out”.

Operationally: “cigarettes are smoked unlit with standard smoking machine operating parameters (Method S-2) selected to mimic human smoking behaviour (for example, 35 ml puff, 2 second duration). The Smoking Machine Protocol (Method S-2) could not be found in a database search of different tobacco documents. Each cigarettes tested was “dry-puffed” (unlit) five times. The filter fibres released were trapped on a Millipore filter pad that had replaced the standard Cambridge glass fibre filter pad used commonly for assaying particles (“tar”) in cigarette smoke.

The white Millipore filter pad was “colored black prior to dry puffing” with a “felt ink marking pen,” undoubtedly to facilitate viewing the white cellulose acetate fibres. According to the protocol, “The fibres, that had been trapped on the Millipore pads, were examined microscopically for number and size.” The size of the fibres was sometimes reported as fibre length: < 50 µm, 50–100 µm, 110–200 µm, 210–300 µm, 310–400 µm, 410–500 µm, and > 500 µm.

We tabulated the cigarettes tested in the “fall-out” assays. A total of 130 cigarette types was identified, and these included coded and brand cigarettes. Most of the cigarettes were coded (n = 116/130; 89%). We were unable to locate in our searches of different databases the key that would allow us to identify the different brands of the coded cigarettes. Popular cigarette brands (n = 14) included those of Philip Morris, Inc as well as cigarettes of its competitors. These cigarettes included: Avalon, Benson & Hedges, Cambridge, Kent, L&M, Lark, Marlboro, Merit, Montclair, Parliament, Salem, Winston, Saratoga, and Tarleton. The brand tested most frequently was Marlboro. For a given cigarette brand, different filter designs were thought to have been tested (for example, Marlboro KS-test and Marlboro KS-cont; see below).

We have reviewed the test results presented in all of the “fall-out” documents. For all tests, filter fibres were released from all types of cigarettes tested.

The results of two filter fibre “fall-out” studies have been selected for presentation as representative of the filter “fall-out” tests performed.

In the first study, a 1962 investigation entitled “Project #8101” was conducted to measure the differences in the “fall-out” of “CA” (cellulose acetate) fibres from 25 Marlboro and 25 L&M cigarettes. The L&M cigarettes released a total of 231 fibres whereas Marlboro cigarettes released 56 fibres.

In reporting these results, it was noted that: “The “fall-out” particles from Marlboro are also smaller in length and diameter.” The reader wishing to view the large number and diverse size of the filter fibres released in these “fall-out” assays may do so by retrieving the photographs in this report.

The second study that we have selected to profile is a relatively recent (1995) project, entitled: “Background information on cigarette filter fibres release upon smoking.” As was the intent of the previous study, this project compared the fall-out of fibres from different brands. Cigarettes tested included Marlboro KS-test, Marlboro KS-cont, Marlboro 100-2C1, Lark Special Lts 5D2, and Cambridge 100-1A1. In all assays, fibres were released from the filters. The total number of fibres released, from 10 cigarettes of each of the five types of cigarettes were: 37, 36, 30, 20, and 125, respectively.

**Measurement of carbon particle “fall-out”**

A 1985 document entitled “Carbon particle fall-out” authored by Nancy R Ryan, defines “Method No. S-43”, which is a protocol that describes the equipment and procedures for assaying the “fall-out” of carbon particles release from cigarettes with charcoal filters. In this protocol, the term fall-out was defined as: “Loose particles that are drawn out of the filter during puffing and collected on filter media are called carbon particle “fall-out”.” This carbon particle “fall-out” protocol S-43 shares many features (for example, authorship, date, goal, methods and equipment) as that of the protocol S-42 for filter fibre “fall-out”.

The purpose of protocol S-43 was to enumerate and size carbon particles that had been released from cigarettes with charcoal filters. The apparatus (for example, standard Philip Morris, Inc smoking machine) for testing and procedure is similar to that of the filter fibre “fall-out” protocol (Method No. S-42; see above).

Tests for the release of filter fibres and carbon particles have been conducted for 15 years before the two 1985 “fall-out” tests measuring the “fall-out” of carbon particles release from cigarettes with charcoal filters.
Carbon particles that ranged in size from 5–120 µm.

Tests revealed that the filter of Parliament cigarettes released the particles contaminating the filter face were small, and many of the specks would surely “fall-out” into mainstream smoke during puffing.

Indeed, repetitive tests showed that carbon particles were released. In a 1970 test of: “Fallout of cigarette filter material” (10 cigarettes, 5 puffs) carbon particles were sized and enumerated. The results were as follows: size range 5 µm (n = 20 particles), 6–10 µm (n = 38), 11–20 µm (n = 22), and 21–30 µm (n = 14), etc. A total of 124 carbon particles was recorded.

In the same year, 1970, Parliament cigarettes of Philip Morris, Inc (80, 85, and 100 mm length) were tested. The Parliament cigarette was unique in that it had a 5 mm recessed charcoal filter. The novel filter was designed to prevent the tongue from touching the filter face. However, tests revealed that the filter of Parliament cigarettes released carbon particles that ranged in size from 5–120 µm.

We reviewed the test results in all of carbon “fall-out” papers. This review showed that carbon particles were released from all cigarettes tested. noteworthy is that, in some studies, the particles released from cigarette filters were described as: “...too numerous to count”.54

**Filter fibre denier and morphology**

A 1986 document entitled “Denier per filament of cigarette filter fibres”, signed by Nancy R Ryan, defined “Method No. 21–30 µm (n = 14), etc. A total of 124 carbon particles was recorded.

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**Filter fibre denier and morphology**

A 1986 document entitled “Denier per filament of cigarette filter fibres”, signed by Nancy R Ryan, defined “Method No. F-13” which describes procedures for examining fibres (cellulose acetate cigarette filter) to define the shape and denier per filament.5 Other protocols and methods were referenced in this document, but could not be located (that is, “Method Number F-14”55). Another related protocol, “Method F-12” describes the paraffin embedding and preparation of fibres from cigarette filters.56 These documents illustrate in-house studies at Philip Morris, Inc were performed for many years to characterise the shape and morphology of cigarette filter fibres, and to measure the release of the cellulose acetate fibres during normal smoking conditions.

**Personnel participating in the “fall-out” studies**

We generated an alphabetised listing of different individuals at Philip Morris, Inc who were named in the 61 “fall-out” documents (for example, “B”, “From”, “cc” or in the written text). After excluding those entries that appeared to be duplicates (for example, J Griffin and JH Griffin, Jr), approximately 135 individuals were identified. The frequency that a name was cited was then determined. In addition, an attempt was made to identify the employment title of those persons named most often.

Nancy Ryan was as identified in a 1981 document as a Laboratory Technician IV. She worked in the analytical laboratories of Philip Morris, Inc under the supervision of Dr Tom Osdene and, for a short time, under the direction of Dr William A Farone. The “fall-out” documents as well as Dr Farone has identified Nancy Ryan as the individual who performed most of the filter fibre and carbon particle “fall-out” assays. Nancy Ryan wrote approximately three quarters (75%; n = 38/61) of the “fall-out” documents, and her name appeared in documents written over a 16 year period (1977 to 1993).

A partial listing of research executives of Philip Morris, Inc named in the inter-office communications included: O McComas (president); R Seligman and H Wakeman (vice president); W Farone and T Osdene (research directors). Further, by way of example, a 1983 correspondence addressing “fall-out” assays that had been conducted for a new type of filter had been distributed to 39 individuals, 15 of whom were addressed as “Dr”. Thus, the results of the fall-out assays were broadcasted widely and for many years to senior scientists and corporate executives.

William Farone, PhD, was employed by Philip Morris, Inc from 1976 to 1984, and served as the director of applied research from 1977 to 1984. Dr Farone is named in 18 of the 61 “fall-out” documents. Dr Farone is an expert in cigarette design and engineering. His is also a specialist in product research and marketing.

Dr Farone’s recollection, a communication of 1997 that reviews the “fall-out” assay memos, and the time line of the “fall-out” assays confirm that the tests were performed routinely. The most recent filter fibre “fall-out” test results that we obtained were those presented in a 1999 report. Thus, the discharge of cellulose acetate filter fibres and carbon particles has been known for 42 years, and tested routinely in “fall-out” assays that have been conducted for 40 years by Philip Morris, Inc (table 1).

Dr Farone has acknowledged that Philip Morris, Inc was concerned as to the possible health risks associated with inhaling filter fibres and carbon particles. Dr Farone reported to us that a claim made by Philip Morris, Inc that the filter fibres were too big to get into the lung was based upon an aerodynamic diameter concept only, and emphasised that the concept was an unproven hypothesis. Some of the fibres that “fall-out” of the filter are likely to be deposited in the mouth and upper airways. However, given the known frequency with which most people smoke cigarettes, Dr Farone asserted that it is inevitable that some of the cellulose acetate fibres would be inhaled.

One of the primary objectives in applying a plasticiser is to bind the fibres. The plasticiser, however, is applied before the cigarette filter is cut and other cigarette manufacturing processes. Thus, the bonding agent may curtail but would not eliminate the formation nor the release of filter fibre fragments. Dr Farone noted also that the introduction of ventilation holes in the filter would increase the flow of air though the filter and, thereby, may increase the potential for release of broken fibres lying freely on the cut surface of the filter.

**Document destruction at Philip Morris, Inc**

We recovered a document entitled “Notice of active records disposal” that was sent to Nancy R Ryan, “Cigarette testing, research & development”, on 1 February 1994 from Information Security (Central File), Philip Morris USA. In this confidential document, Ms Ryan was to “initial each line below to indicate that the appropriate records have been destroyed”. Further, it stated: “you must attach an explanation for those records that are retained beyond their retention period.” Documents that were initialed as having been destroyed included: “Projects”, “Projects–Administrative”, “Diaries”, and other papers. This document request was signed by Nancy Ryan and dated 18 February 1994.

Document management and destruction for some companies is a routine part of business operations. However, the document destruction memo to Ms Ryan (1994) was issued soon after the 1993 published reports of our research documenting the release of fibres from cigarette filters (table 1; also see below: “Filter contamination . . . “, “Laboratory research . . . “, and “Discussion”). While this may be coincidence, we note that this declaration was issued only once—our searches of different document web sites failed to locate document destruction declarations issued to Ms Ryan in the preceding or subsequent years.

**Filter contamination not disclosed by Philip Morris, Inc**

Having established that Philip Morris, Inc knew for approximately 40 years that cigarette filters released cellulose acetate fibres and carbon particles, we undertook a search of the scientific literature to determine whether the results of these
experiments had been reported. Our efforts included a search of publications referenced in Medline, PubMed, Tobacco Abstracts, Chemical Abstracts, and CORESTA papers and reports.

These and related attempts failed to locate a report disclosing any of the results of the “fall-out” studies. A search was made of the Tobacco Abstracts, an annual publication of papers addressing tobacco related topics. Of the approximately 33 588 papers published (1967 to 1982; mean 2785 papers/year), we identified 1591 papers discussing “cigarette filters”. However, of these 1591 papers, none reported: (a) the discharge of filter fibres, including cellulose acetate fibres of conventional cigarettes and asbestos fibres found in the Kent Micronite cigarettes; (b) charcoal or carbon from cigarettes with charcoal filters; and (c) protocols or observations addressing the integrity or quality control issues of cigarette filters.

Also, there were no reports from Phillip Morris, Inc that addressed the release of fibres, carbon or other filter elements of the cigarette filters in any of the papers presented during the last 37 years at the CORESTA meetings or special symposia.

The absence of papers from Phillip Morris, Inc examining these issues is remarkable in light of the fact that nearly all cigarettes manufactured during the past two decades have a cellulose acetate filter.

**Laboratory research of filter “fall-out” contaminants**

Given the duration of the investigation of Philip Morris, Inc that characterise fibre “fall-out” of diverse cigarette brands, we anticipated acquiring the results of toxicology studies that assessed the health risks of inhaling and/or ingesting the tar coated filter fibres and carbon granules that had been released from the filter during smoking. Results of toxicology tests were not found in any of the “fall-out” documents.


Our search of multiple databases failed to locate documents presenting the results of toxicology studies of fibres and particles that are known to be discharged from cigarette filters during normal smoking conditions. At a minimum, we expected to find laboratory notebooks or at least photocopies of selected notebook pages. Not a single page was found.

**US patents for improved filters**

A search of US patents was undertaken to identify inventions that would prevent and/or reduce the discharge of filter elements into the mouth of smokers. The search retrieved 607 US patents that had been awarded for cigarette filters from 1971 to 2001 (mean (SD) n = 19.58 (7.07) patents/year; median = 19). The largest number of US patents awarded for cigarette filters in any given year was 36; these patents were awarded in 1987.

Many patents described inventions for improving cigarette filters. Some of the discoveries were for: (a) various cigarette smoke purifying materials (for example, diverse fibre types, surface modified fibres, woven fibres, mesh material, open cell sponge items, solid porous structures, and granular materials; (b) various filter designs (for example, compound and multisection filters); (c) filter ventilation (for example, increased air flow; reduction of cigarette smoke tar and gases); (d) selective elimination of specific toxins in mainstream smoke (for example, polycyclic aromatic hydrocarbons (PAH); and (e) delivery of smoke modifiers (for example, flavourings and humectants).

Two US patents have been awarded to Hauni Maschinenbau AG for different methods and apparatus for decontaminating the exposed surfaces of filter mouthpieces in smokers’ products. Methods used to “decontaminate” the cellulose acetate fibres from the filter mouthpiece were: (a) pneumatic systems, including the use of suction chambers; (b) electrostatic precipitation; (c) application of smoke permeable layers of filter material to overlie the end faces of the mouthpieces; and (d) a bonding procedure in which some of the loose fibres would be affixed to the mouthpiece with a solvent or with the application of heat to the cut surface of the mouthpiece.

Preventive measures could be employed that would reduce the formation of broken and loose filter fibres during cigarette manufacturing including the use of heat or lasers to cut the filters. In effect: “the invention is to provide a simple, reliable and inexpensive method of preventing uncontrolled or random separation of fibres and/or fragments of filter material from filter mouthpieces”.

Also noted in these two patents is that in the manufacturing of cigarettes, considerable quantities of “fragmentised” tobacco particles are collected and reintroduced into cigarette making machines. Both patents declare that: “This is not advisable as the cellulose acetate fibres would be placed in the tobacco column.” The cellulose acetate fibres in the tobacco column are burned and would emit additional toxins into mainstream smoke.

We undertook a search of various databases to locate documents of Philip Morris, Inc that addressed their efforts, or discussions with manufacturers of cigarette machines, to rectify the filter fibre and charcoal particle “fall-out”. No documents were found.

**DISCUSSION**

The cigarette filter studies reported herein have focused on the research conducted by Phillip Morris, Inc because: (a) the unique “fall-out” papers provided the largest collection of documents from any single tobacco company that address the release of cigarette filters fibres and particles; (b) the research described in the “fall-out” studies extended for four decades during which time cigarette design had changed considerably and the health risks of smoking had been more fully delineated; (c) the analytical laboratories of the world’s largest tobacco company are perceived as having the best resources to undertake studies of defective filters (for example, funding, personnel, technology, and equipment); and (d) the mass cigarette production facilities would presuppose frequent collaboration, partnerships, and contracts with manufacturers of filter fibres (for example, “tow”), machines for making filter rods, plasticisers, and other items.

The term “fall-out”, coined by Philip Morris, Inc, depicts the ease with which the loose fibres and particles are puffed from the cut surface of the cigarette filter. Collectively, the 61 “fall-out” papers establish that cellulose acetate fibres and carbon particles are emitted from the filters of all cigarettes tested over a period of many years and under normal smoking conditions. Moreover, the filter defect is universal and widespread, and it is not restricted to a given cigarette brand, filter type or tobacco company.

Notwithstanding, the “fall-out” assay used is perceived as having many shortcomings which, if rectified, would demonstrate that more particles and fibres are released from the cigarette filter. For example, the cigarettes tested were never lit. As early as 1963 it was noted that: “This (unlit draw method), however, does not give us any information on the amount of carbon fall out to be expected when these cigarettes are smoked in the normal manner.” Thus, it would be reasonable to expect that more carbon particles or cellulose acetate fibres would be released if lit cigarettes had been tested.

Filter fibre fall-out and carbon fall-out protocols stated that five puffs were collected for each cigarette. This is significantly

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lower than the 8–10 puffs that are prescribed in standard cigarette smoking procedures.64,65. Plugging the filter vents with a black felt tip marker may occlude some of the micropores (0.8 µm) of the membrane. Plugging the holes would reduce air flow and impair filtration. Additionally, the organic solvent of the ink may react adversely with the filter membrane. Ironically, the painting procedure was unnecessary because black micropore membranes similar to the white ones used by Philip Morris, Inc have been available from Millipore for many years. Philip Morris, Inc, however, continued to use the membrane painting practice until 1999 at which time the assay protocol was revised.66

In experiments on Lark cigarettes that have a charcoal filter, we showed that carbon granules are released from nearly all of the cigarettes. This was thought to be caused primarily by the discharge of charcoal granules from the central cavity of the filters of these cigarettes would have more, and thousands of bonded long fibres. Further, there is no evidence that the discharged loose filter fragment or carbon particles would reflect a significant loss in filtration efficacy. These and other objections permit the reviewer with no alternative than to conclude that the intent of the “fall-out” tests were to address harm.

We searched different databases to determine if companies other than Philip Morris, Inc were aware of the cigarette filter defect. Our findings showed that several other companies have recently investigated the release of cellulose acetate filter fibres. Variable results have been reported (table 1). This may be attributed to inappropriate methodologies or inexperience. In this respect, it is noted that no standardised testing procedures have been adopted.

Note that none of the companies who have reported studies that have been undertaken to measure the release of fibres from cigarette filters have made reference to the extensive “fall-out” studies of Philip Morris, Inc. Has Philip Morris, Inc been successful in hiding their observations from other companies for several decades?

In 1993, the RJ Reynolds Tobacco Company (RJR) argued, albeit unconvincingly, that cigarette fibres are not released from cigarettes67—(table 1). RJR cites a paper by Langer and colleagues,68 presented at a 1988 conference on “alternative than to conclude that the intent of the “fall-out” tests were to address harm. Results of studies presented in this report have been documented that cellulose acetate cigarette filter fibres were released from modern day cigarettes. Specifically, filter fibres were released from 12 different US cigarette brands; two brands from each of six different US companies. All cigarettes tested were purchased from local vendors.69 Cellulose acetate filter fibres have a chemical composition similar to that of the filtration membrane. Thus, no cigarette filter fibres could be detected using the assay employed.

Before learning of the “fall-out” studies of Philip Morris, Inc, we published the results of comprehensive tests documenting that cellulose acetate filter fibres were released from modern day cigarettes. Specifically, filter fibres were released from 12 different US cigarette brands; two brands from each of six different US companies. All cigarettes tested were purchased from local vendors.69 Cellulose acetate filter fibres were implanted in mice for six months. The fibres withstand degradation and retained the tobacco brown colour and bright fluorescence of the tobacco tar that had been adsorbed from cigarette smoke. We reported also the presence of cellulose acetate cigarette filter fibres in human lung tissue. In his critique of this study, tobacco spokesperson Professor Dr F Adkiofer noted that: “With high probability, the fibres which were seen by the authors in the lungs of smokers with lung cancer are in fact cellulose acetate fibres.”

Results of studies presented in this report have been confirmed and extended by investigations of cigarette smokers. The participant smoked a popular US filter cigarette in his/her usual manner, but was instructed not to inhale the smoke. Mouth washes of water were collected before smoking, at different intervals during smoking, and after smoking. The results showed that washes collected from all subjects and for all cigarettes smoked contained cellulose acetate cigarette filter fibres (range 2–25 fibres). In contrast, mouth washes obtained before smoking had no fibres. Notable is that none of the companies who have reported studies that have been undertaken to measure the release of fibres from cigarette filters have made reference to the extensive “fall-out” studies of Philip Morris, Inc. Has Philip Morris, Inc been successful in hiding their observations from other companies for several decades?

In experiments on Lark cigarettes that have a charcoal filter, we showed that structural integrity granules are released from nearly all of the cigarettes. This was thought to be caused primarily by the discharge of charcoal granules from the central cavity of the
The release of filter fibres and charcoal granules from Lark cigarettes was confirmed also in experiments using smoking tubes\(^{24,25,32,33,36,45,46}\), see also particle “filter particle fall-out” references.

We have discovered that glass fibres and glass particles contaminate the filters of Eclipse and Premier; these are cigarette appearing, low smoke, “reduced risk” products of RJR.\(^{102,103}\)

Others have shown that “African blue” crocidolite asbestos fibres were discharged in large numbers (\(n > 100,000\) in the first puff) from Kent Micronite cigarettes. These cigarettes were introduced in 1952 by the Lorillard Tobacco Company, and the filters were withdrawn from the market in 1956.\(^{104}\)

Collectively, our investigations have identified diverse types of filter elements, including fibres (for example, cellulose acetate, glass and asbestos) and particles (for example, charcoal).

It is known commonly that cigarette smoke is a complex aerosol consisting of a particulate phase (“tar”) and vapour or gaseous phase (for example, carbon monoxide). Components in these two phases arise from the pyrolysis or burning of the tobacco, and are assayed routinely. Another phase of cigarette smoke has been identified. This third phase is unique in that it does not arise as a result of tobacco pyrolysis. The third phase is the diverse material of the filter that is released from the filter during smoking. This newly defined phase of cigarette smoke must be characterised for content and dose, and with the same rigour used in prior toxicological tests of the tar and vapour phases.\(^{105}\)

Concern of the health risks associated with the inhalation of cellulose fibres from cigarette filters was discussed in the late 1950s.\(^{21,106}\) One example is that of a memo written more than 44 years ago to O P McComas, the president of Philip Morris, Inc.\(^{21}\) The letter reports in detail discussions among senior officers of many prominent companies of the cigarette industry (for example, Philip Morris, Inc, American Tobacco Company, Imperial Tobacco Company, and Reemstma), and manufacturers’ of cigarette filter material (“tow”; Baumgärtner, Tennessee Eastman, “Rochester Laboratories” [presumably Kodak]) and cigarette making machines (Molins).

An excerpt from this letter reads:

“He wanted to know whether or not we had heard the rumors regarding the dangers of using Tennessee Eastman’s Estron CA [CA, cellulose acetate] type tow in filter cigarettes. He said when an Estron type plug is cut on a making machine, there always remains a few loose, hard particles of filament. These loose hard pieces of material are then sucked down into the lungs of the smoker and are considered to be capable of producing silicosis.”

Two years later, in 1959, the Food and Drug Research Laboratories presented the results of studies that were contracted by Philip Morris, Inc. These tests showed that fibres and fine particulate matter were puffed from the filters of all cigarettes tested, and under conditions simulating normal smoking. The cigarette brands tested (Kent, L&M, Marlboro, Salem, and Winston) were purchased from stores in different boroughs of New York.\(^{107,108}\)

Also notable is a comprehensive 131 page report of 1959 that showed that cigarette filter filaments and charcoal granules were released from all popular filter cigarettes studied (Camel, Chesterfield, Kent, L&M, Lucky Strike, Marlboro, Philip Morris, Tareyton, Winston, and Viceroy). These studies were funded by the Brown and Williamson Tobacco Company.\(^{109}\)

A recent study has assessed consumers’ knowledge and beliefs about the safety of cigarette filters. In this survey, participants were asked: “If cigarette fibres become loose, and the cigarette companies are aware of this, do you think that they have an obligation to warn the public about this?” All smokers and former smokers in this survey responded “yes.”

Also, the participants were asked: “If cigarette filter fibres are inhaled into the lung or eaten, would you consider this an additional health risks beyond the exposure to tobacco smoke?” Of current smokers surveyed, 90% responded “yes”. Of former smokers, 96% responded “yes”. Of significance was the fact that the panel members responded that they perceived that the filter fibres that had been “eaten” imposed a health risk beyond the exposure to tobacco smoke.

Philip Morris, Inc has also performed field tests for which panel members have compared the filters on experimental cigarettes with filters of brand cigarettes (for example, Virginia Slims, Winston, Benson & Hedges, Marlboro, and Premier). By way of example, in 1988, Philip Morris, Inc conducted a study of 74 one-on-one interviews and five focus groups illustrated that smokers expressed a contemptuous reaction to the “fiberglass” used in RJR’s Premier. Some panelists were quoted by Philip Morris, Inc for being fearful of the health risks of inhaling the glass fibres. The issue of the health risks associated with the inhalation of plastic-like cellulose acetate filter may have been addressed, but the results have not been disclosed.\(^{109}\)

What this paper adds

Almost all cigarettes sold worldwide have a filter; thus, the filter is an integral part of today’s cigarette. Furthermore, most filters are made of a cylindrical rod or plug that consists of thousands of plastic-like cellulose acetate fibres. We, however, do not know what studies have been conducted by the tobacco companies to: (a) address filter defects that may arise during cigarette manufacturing whereby loose debris of different forms (for example, fibres, fragments, particles, crystals, and fines) contaminate the surface of the filter and is released during normal puffing; and (b) assess the toxicology and human health risks of these diverse filter elements that are discharged into mainstream smoke.

This paper discloses that Philip Morris, Inc has known and concealed for approximately 40 years that fibres and particles “fall-out” of the filter of cigarettes during smoking. Other companies have assessed also the discharge of filter fibres. In addressing this filter defect, the tobacco industry’s response has been variable, ranging from denial of the discharge of filter fibres to the development of innovative technologies for correcting and preventing the problem. Consumers have not been informed of the filter defect. Furthermore, there is no indication that existing corrective technologies and invention have been uniformly implemented. Summarily, the tobacco industry has been: (a) derelict in concealing information of filter defects; (b) negligent in implementing technologies available to prevent or reduce the emission of filter elements; and (c) wrongful in not investigating the toxicology and harm associated with defective filters of today’s cigarettes that are being marketed worldwide.
defective filters. Cigarettes with defective filters is like the inhalation by unconscious shallow normal breathing. Ostensibly, the probability of inhaling fibres and particles from the two forms of inhalation is different. Would it not seem reasonable to theorise that fibre fragments and carbon particles would be inhaled from the filter by a smoker who places a cigarette to the mouth, seals the cigarette with the lips, and drags a bolus of 35–55 ml of smoke deep into the lung? Many smokers repeat this exercise 200–400 times daily, and each day of the year. Thus, existing paradigms defining the dynamics of inhaled airborne pollutants cannot be applied to the inhalation of debris sucked from cigarette filters.

Fibres and particles that “fall-out” of the filter will be ingested and serve as a solid phase matrix for delivering adsorbed tobacco tar throughout the gastrointestinal tract. Could the fibres and particles released from the cigarette filter serve as aetiological agents or confounders for pathologies of the gastrointestinal tract?

Tobacco companies bore the burden of performing the toxicology studies necessary to assess the human health risks of the defective filters and, specifically, the dangers associated with the daily inhalation and ingestion of the substances discharged from the filter during normal smoking. All consumers, including smokers, have the right to be fully informed of product defects and the potential risks that they impose so that they can make an educated decision in selecting their cigarette purchases.

The inhalation and/or ingestion of toxic coated plastic fibres and carbon granules released from contaminated and defective filters is not intended to be part of the smoking experience. The filter is intended to reduce exposure to cigarette smoke toxins—any elements from the cigarette filter that are likely to be puffed into the lung must be recognised as pollutants. For a company to knowingly and willfully withhold this information from consumers about the known contamination of cigarette filters, as Philip Morris, Inc had done in the past and continues to do even today, is wrong.

In summary, our work documents that Philip Morris, Inc has:

(a) known for more than approximately 40 years that filters of popular US cigarettes release filter fibres and charcoal particles during smoking;
(b) established protocols for assaying the “fall-out” of filter fibres and charcoal granules;
(c) utilised these protocols routinely to count and size filter fibres and charcoal particles that are released from a filter;
(d) undertaken comparative studies assessing the “fall-out” of filter fibres and carbon granules from their cigarettes and those of their competitors;
(e) continued the “fall-out” studies until 1999;
(f) known of the potential health risks associated with the “fall-out” of fibres and particles from the filter;
(g) understood that the discharged filter elements were likely to have adsorbed diverse toxins from the cigarette smoke;
(h) not disclosed the findings of the filter fibre “fall-out” and carbon granule “fall-out” to individuals who smoked their filter cigarettes as well as to scientists, physicians, public health officers, regulatory authorities, and others.

An additional 36 memos with carbon or fibre or filter and “fallout” in the title have been identified from documents of the central file of Philip Morris USA (confidential). Bates No. 2065031293-2065031309.

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance of literature retrieval and database searches by different personnel at the Roswell Park Cancer Institute, including Ms Gayle Ahlbus, Senior Medical Librarian, and Mr Craig Steger, Cancer Prevention, Epidemiology Biostatistics. We wish also to thank Dr WA Farone, who served from 1977 to 1984 as the Director of Applied Research at Philip Morris, Inc, for sharing with us his knowledge of the “fall-out” studies and issues related to cigarette design. Likewise, we are particularly indebted to Dr Dietrich Hoffmann, Associate Director, American Health Foundation, for the many hours that he devoted in assisting us.

Supported in part by NIH grants CA-16056, CA-67827, CA-77021-03, CA-97656-01 and Roswell Park Cancer Center Support Grant P30 CA 16056 from the US Public Health Service, and grant 09734 from the Robert Wood Johnson Foundation.

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REFERENCES


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Cigarettes with defective filters marketed for 40 years: what Philip Morris never told smokers

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*Tob Control* 2002 11: i51-i61
doi: 10.1136/tc.11.suppl_1.i51

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