

# **Review of the Federal Trade Commission Method for Determining Cigarette Tar and Nicotine Yield**

Harold C. Pillsbury, Jr.<sup>1</sup>

The “Federal Trade Commission (Commission or FTC) method” is the methodology that the Commission adopted almost 30 years ago for testing cigarettes. This methodology is still used today by the Tobacco Institute Testing Laboratory (TITL), with some minor modifications. The FTC method determines the relative yield of individual cigarettes by smoking them in a standardized fashion, according to a predetermined protocol, on a smoking machine. The FTC test method was based on the “Cambridge Filter method” developed by Ogg (1964), which called for 2-second, 35-mL puffs to be taken until a 23-mm butt length remained on the cigarette. More about how these parameters were selected is presented below.

For the testing procedure, as implemented initially by the FTC’s cigarette testing laboratory and currently by TITL, cigarettes are collected by an independent firm that purchases two packages of each cigarette variety<sup>2</sup> in each of 50 locations throughout the United States. (If some varieties or brands are not available in certain locations, additional packs will be purchased in locations where they are available.) They are mailed to the testing laboratory; the postmark serves as verification that they were purchased in different locations. Individual cigarettes to be tested are selected on a random basis, two from each pack. Before being smoked, the cigarettes are “conditioned” by being placed on storage trays in a room maintained at 75 °F and 60 percent relative humidity for not less than 24 hours.

The machine used in the Commission’s laboratory had 20 “ports” (openings); the smoking machine currently used by TITL also has 20 ports. Each opening is fitted with a filter holder, into which a cigarette is inserted for smoking, and a filter pad, on which particulate matter from the cigarette smoke is collected. Gases pass through the pad and are collected in specially designed plastic bags.

---

<sup>1</sup> These remarks are the views of the staff of the Bureau of Consumer Protection. They do not necessarily represent the view of the Commission or any individual commissioner.

<sup>2</sup> A particular brand of cigarettes may have more than a dozen varieties, depending on whether it is available in different lengths, in regular and menthol flavors, in hard and soft packaging, and in regular, light, and ultralight versions. For example, the Commission’s 1994 tar and nicotine report lists 20 varieties of Marlboro.

The machines are calibrated to take one puff of 2-second duration and 35-mL volume every minute. Cigarettes are smoked to a butt length of 23 mm or the length of the overwrap plus 3 mm, whichever is longer. When the cigarette has been smoked down to the prescribed length, it burns through a string that has been placed on that mark; this causes a microswitch to be flipped, which in turn disconnects that particular port of the smoking machine. (Although this seems like a fairly unsophisticated way of terminating the test, more sophisticated methods—such as infrared detectors and thermal sensors—have been tried and rejected over the years.)

Five cigarettes of each variety are smoked, one at a time, using the same filter holder.<sup>3</sup> (A total of 100 cigarettes of each variety are smoked to get the official tar, nicotine, and carbon monoxide ratings.) After the smoke from those five cigarettes has been filtered through each filter pad, the holder is removed and weighed. The difference between the weight of the holder before and after the smoking process divided by the number of cigarettes smoked is the total particulate matter collected from the cigarette smoke.

The filter pad is then extracted with a solvent,<sup>4</sup> and the moisture content is determined by injecting a measured amount of the extract into a gas chromatograph and comparing the resulting peak against the standard curve. Ratings for the three constituents reported by the Commission are then determined as follows:

- Nicotine: As with moisture, a specified amount of the extract from the filter pad is injected into a gas chromatograph, and the resulting peak is compared against the standard curve.<sup>5</sup>
- Carbon monoxide: The gas collected in the plastic bag is passed through an infrared detector to determine carbon monoxide levels.
- Tar: Tar level is determined by subtracting water and nicotine levels from total particulate matter.

Tar and carbon monoxide figures are rounded up or down to the nearest milligram, while nicotine figures are rounded to the nearest 10th of a milligram. Varieties with tar and carbon monoxide results below 0.5 mg per cigarette or nicotine results below 0.05 mg are reported as <0.5 mg or <0.05 mg, respectively, because the FTC test method is not sensitive enough to report these components at lower levels.

Although the ratings are based on 100 cigarettes, at least 150 (and preferably 200) cigarettes of each variety are needed for the test to ensure

---

<sup>3</sup> To make certain that the machine is working properly, at least 4 of the 20 ports are reserved on each run for "monitor" cigarettes—cigarettes with known yields for tar, nicotine, and carbon monoxide.

<sup>4</sup> The solution contains extractant and internal standards: 2-propanol containing 1 mg anethole per mL as an internal standard for nicotine and 20 mg ethanol per mL as an internal standard for water.

<sup>5</sup> Ultraviolet spectroscopy was used to determine nicotine until 1980, when it was replaced by gas chromatography.

that 100 are successfully smoked. Common technical problems that can cause a filter pad to be discarded include lighting failures and port leaks. During the last year of the FTC laboratory's operation, fewer than 300 varieties of cigarettes were tested, and the testing cycle (which included curing, marking, and smoking the cigarettes, etc.) lasted approximately 12 months. There were 933 cigarette varieties rated by the TITL in the Commission's 1994 report.

The author once had the opportunity to ask Dr. Ogg (who worked as a tobacco chemist for the U.S. Department of Agriculture) how he came up with the specific parameters of his protocol. He said that he had based them on observations of how people smoke under different conditions. He had spent a lot of time watching people smoke (at the office, on the street, etc.), sometimes timing them with a stopwatch. His observations told him that people smoked differently under different conditions. For example, someone deep in thought might take only one or two puffs before the cigarette burned out, whereas someone who seemed extremely nervous might puff constantly. In short, there was no such thing as an "average" smoker and no way to derive a set of testing parameters that would replicate actual human smoking, so Dr. Ogg had to select parameters that seemed reasonable in light of his observations.<sup>6</sup> Dr. Ogg also collected cigarette butts from ash trays in hotels, restaurants, and offices and measured how long they were; the resulting average length became the butt length called for by his protocol.

When the Commission adopted a slightly modified version of the Cambridge Filter method in 1967 for use in its newly opened cigarette testing laboratory, it was the author's opinion that the Commission's procedures (as implemented on the 20-port smoking machine selected by the Commission) were clearly superior to all other methods currently in use at that time. The FTC method had its limitations, most significantly that the information it generated would not tell any individual smoker how much tar and nicotine he or she would get from a particular brand of cigarette. However, there was simply no way to get that information, and the FTC method did provide a smoker with accurate comparative information about the relative amounts of tar and nicotine delivered by various cigarettes when they were smoked in precisely the same manner. In addition, it provided a uniform analytical procedure that could be replicated in different laboratories simultaneously and in the same laboratory over time; therefore, not only could many brands of cigarettes be compared with each other at any time, but long-term pictures of tar and nicotine levels over the years also were possible.

---

<sup>6</sup> During the December 5-6, 1994, National Cancer Institute conference, it was learned that a protocol using the same parameters for the testing of cigarettes had been proposed by The American Tobacco Company researchers many years before Dr. Ogg published his article (Bradford et al., 1936) ("arbitrarily" selecting a 2-second, 35-mL puff once a minute, although another researcher who had studied human smoking habits used a 40-mL puff).

## **QUESTION-AND-ANSWER SESSION**

DR. HARRIS: I was curious about the very last statement on the tape: The results are sent to the cigarette manufacturers who, in turn, report the numbers to the Federal Trade Commission?

MR. PILLSBURY: Yes. We get the tar and nicotine data directly from the cigarette manufacturers so that we can hold them responsible if there is anything wrong with the numbers.

DR. HARRIS: To your knowledge, do the numbers reported under the compulsory process by the manufacturers ever deviate from those that are measured in the Tobacco Institute laboratory?

MR. PILLSBURY: The only thing I can tell you is that they are checked.

DR. STITZER: Could you remind us how the original Cambridge Filter method was altered when the FTC method was developed?

MR. PILLSBURY: The original smoking machine was a four-port smoker that used a column of water to draw from the cigarettes. When this new machine came out, the filter pads and the holders were pretty much the same. The only thing that has been changed is that the machine has been modified so that carbon monoxide can be analyzed at the same time that the cigarettes are being smoked.

DR. STITZER: So, there wasn't a puffing protocol that went along with the original method?

MR. PEELER: We published, at the time that we adopted the method, a fairly detailed protocol for how the test was supposed to be done. I suppose the question is, did that protocol that we published differ from the original method in the parameters that were required?

MR. PILLSBURY: No. They were pretty much the same as in the original method.

DR. RICKERT: How much of a difference would you have to have in tar yields between two brands before they would be considered to be different in the statistical sense?

MR. PEELER: We publish the numbers and try to have a large enough sample so that there are differences in those numbers. But the question of whether there is a significant difference in those numbers is what we need to know from you.

DR. RICKERT: What I am referring to is that on the tables in the UK there is a footnote that reads, "Ignore differences in 2 mg in tar and CO," and I was wondering whether that is the same sort of position that we have here?

MR. PILLSBURY: The only thing that is done is they are rounded. Five and above are rounded up; four and down are rounded down. We make no criteria as to whether one with 14 mg is better for you than one with 15 mg. We are just publishing the ratings of the cigarettes as they fall.

MS. WILKENFELD: I think the answer is that, at least originally, we used to publish the table with a standard deviation and that therefore there was a significance between each degree of tar yield. We do not have confidence in yields below .5, and that is announced in the report.

DR. PETITTI: About how long does it take to finish puffing one cigarette, and what is the difference in the time that it might take to puff a cigarette that is a very-high-tar cigarette vs. a cigarette that is very low tar?

MR. PILLSBURY: The difference in the length of time it takes to smoke a cigarette is primarily a factor of how long the cigarette is, how tight the tobacco is packed, how hard it is, and how much gas flows through the cigarettes. Most of the cigarettes take approximately 10 minutes to smoke. We have had longer cigarettes that have gone up to 12 to 13 minutes.

DR. PETITTI: Could you give me a range of the shortest vs. the longest? Is it 5 minutes vs. 15, or is it 9 minutes vs. 12?

MR. PILLSBURY: Any range I would have to give you right now would be a guess, because I haven't followed the range that closely. But I believe that probably the shortest cigarette we have ever had is probably around 6 or 7 puffs per cigarette, and the longest one ran almost 15 puffs, but that was a very long cigarette.

DR. BENOWITZ: Could you explain the rationale for the parameters that are used in the current method? How did you arrive at the present protocol?

MR. PEELER: Let me ask Mr. Pillsbury to address what Dr. Ogg's rationale was in the documents because he actually had an opportunity to discuss that with Dr. Ogg. I think that if you look at the documents that the Commission published at the time of the adoption of the testing methodology in 1967, the Commission is fairly clear that, whatever Dr. Ogg's rationales were, it did not believe it could replicate average smoking conditions. And so it was picking parameters that were essentially fairly arbitrary.

MR. PILLSBURY: When we first started the lab, I talked to Dr. Ogg to quite some extent on this topic. He had actually gone out there with a stopwatch in his pocket and ridden the trains, and watched people in meetings and so forth, and tried to get some feeling for how they were smoking. He came back rather confused, because it seemed as though everybody smoked differently: from the fellow who got on the train and looked at his newspaper and lit his cigarette and never took another puff on it until it burned down to the man who was sitting down arguing with somebody, smoking like mad. So, he came up with what he considered a fairly average way of smoking, so that you didn't get a big long firebox on the end of the cigarette and you kept it burning.

As far as the butt length is concerned, they went out and picked up cigarettes from ash trays in hotels and restaurants and so forth and did actual measurements on those. And the best butt length that they could come up with was 23, or the overwrap plus 3.

MR. PEELER: Again, by the time the Commission adopted the methodology in 1967, the Commission was very clear that it was not trying to establish average smoking parameters.

DR. BOCK: I think that it goes back to the 1938 paper by the American Tobacco Company group. I talked with Bradford and Harlan in Richmond in 1953, and they, again, had gone to parties and watched what their friends were doing. They were the same parameters, I believe, and it was based on a group of probably upper-middle-income-level Richmondtites.

DR. SHIFFMAN: You mentioned that the original FTC action on this was under the FTC's general authority to prevent deceptive advertising. Now, at the moment, you are also reporting the results of these tests to Congress. Has there been any evolution in the FTC's authority in this area, or is it still under this broad mandate?

MR. PEELER: No. The FTC's involvement in this issue continues to be under its authority to regulate deceptive or unsubstantiated claims in advertising. And, in the case of tar and nicotine testing in particular, there are two variations: (1) We do have a voluntary agreement from the industry to include this information in their advertising, and (2) we have had this longstanding practice of sending the reports of this testing to Congress, which was originally established in response to requests from the Commerce Committee. But the only legal authority that we have in this area is our authority to require claims in advertising to be truthful and to be substantiated.

DR. COHEN: I want to return to the point of the statistical significance of the yields. I think that is a very central question for the record. I would just like to point out that there are three different sources of variance here that ought to be considered: (1) variance due to product characteristics, such as product design features; (2) variance due to individual smoking characteristics; and (3) variance due to testing methodology.

Each of those sources of variance can be estimated separately, and it may be very important later on, as the panel does its work, to consider the implications of variance in each of those three separately.

## REFERENCES

Bradford, J.A., Harlan, W.R., Hanmer, H.R. Nature of cigarette smoke. Technique of experimental smoking. *Industrial and Engineering Chemistry* 28(7): 836-839, 1936.

Ogg, C.L. Determination of particulate matter and alkaloids (as nicotine) in cigarette smoke. *Journal of the Association of Official Agricultural Chemists* 47: 356, 1964.