by manipulating the pH of the tobacco. Smokeless manufacturers add compounds and manipulate the design of each smokeless product to create a specific pH. The higher the pH of a product, the more nicotine is transformed from the salt form to "free nicotine." Both forms of nicotine are highly soluble in saliva. However, the free form of nicotine is absorbed more rapidly in the mouth of smokeless tobacco users and into the bloodstream for delivery to the brain. Raising the salivary pH from 7.0 to 8.0 increases the percentage of free nicotine available for absorption from 10% to 50%, a fivefold increase.

Various documents show that UST understands the relationship between the pH of its products and their nicotine delivery. For example, in a deposition, UST's Senior Vice President for Marketing acknowledged that he had written a memo in which he had recommended a specific pH level for a new product and that he understood that there was a relationship between pH and nicotine.⁴⁹² When asked whether pH affected nicotine absorption, he agreed:

⁴⁹⁰ See

Henningfield JE, Radzius A, Cone EJ. Estimation of available nicotine content of six smokeless tobacco products. (Submitted to *Tobacco Control* November 17, 1994.)

U.S. Food and Drug Administration. Report on study of smokeless tobacco products: pH and free base nicotine. November 4, 1994.

U.S. Food and Drug Administration. National Forensic Chemistry Center. Cincinnati Laboratory. *National survey of smokeless tobacco products*. December 13, 1994, memo from Laura Ciolino, Research Chemist to Fred Fricke, Director.

⁴⁹¹ See

Armitage AK. Some recent observations relating to the absorption of nicotine from tobacco smoke. In: Dunn WL. ed. *Smoking Behavior: Motives and Incentives*. Washington, DC: VH Winston & Sons; 1973. Pages 86 (figure 2) and 87.

Henningfield JE, Radzius AC, Cooper TM, Clayton RR. Drinking coffee and carbonated beverages blocks absorption of nicotine from nicotine polacrilex gum. JAMA. 1990;264(12):1560.

⁴⁹² Transcript of Jury Trial Proceedings, Marsee v. U.S. Tobacco, note 317, supra, at pp. 1666-8.