

Alkaloid Reduced Tobacco (ART) Program

I. PRODUCT CONCEPT AND PROJECT OVERVIEW

A. Historical Perspective

The concept of de-nicotinized, or lowered nicotine, tobacco is not a new one. As far back as the early 1950's through the late 1960's, Philip Morris and other companies were experimenting with various means to reduce the nicotine level of tobacco.¹ Extraction of nicotine in tobacco with various organic solvents was attempted. Problems associated with this technology included a long extraction time to achieve the desired nicotine reduction, lack of selectivity for nicotine (other things were extracted), and residual solvent remaining in the tobacco. Ammonia treatment of the tobacco with subsequent steam-stripping was also investigated. Again, problems were substantial residual ammonia ^{selectivity for nicotine} in the tobacco causing an off-taste, ~~and selectivity for nicotine.~~ _{and selectivity for nicotine}

B. Early Testing at General Foods

Philip Morris acquired General Foods in November 1985. The first official meeting of the two R&D Departments (GF and PM) occurred in early December, 1985.² The purpose of this meeting was for the two senior R&D staffs to become acquainted, discuss GF technology and review PM's technology. Information presented at this meeting by GF's staff included a discussion of supercritical CO₂ extraction of caffeine from coffee, among other things. General Foods had extensive experience extracting alkaloids (caffeine) from coffee. They found

¹King Sano produced by Steffano Brothers in Philadelphia, Reynolds #1 Box, marketed in Germany/Switzerland, and Reemstma R6 marketed in Germany were all low nicotine cigarettes.

²K. Houghton, J. Charles, C. Lilly, B. Kuhn, D. Knudson, L. Meyer, M. Hauserman, and F. Resnick. General Foods R&D was represented by R. Guardia, T. Fassina and C. Cante.

supercritical CO₂ to be highly selective for caffeine, the extraction was reasonably fast, and it did not leave any undesirable residue.

As a result, Philip Morris R&D decided to put a project team together headed by C. Lilly to evaluate supercritical CO₂ extraction of nicotine from tobacco. The PM Project Team³ visited Maxwell House R&D in Hoboken, New Jersey to discuss, with Tom Fassina and others, the de-caffeination plant being built in Houston and the possibilities of extracting nicotine from tobacco. Fassina recommended that Philip Morris use the ~~14~~¹⁰⁰⁰ liter extraction unit at GF's Tarrytown, NY R&D facility for initial trials with tobacco. Philip Morris representatives spent three weeks at Tarrytown extracting tobacco using carbon as an absorber (absorbents are materials used to receive the nicotine extracted from the tobacco). The 14 liter extractor was too small for further studies^{because??/reason??} and Fassina recommended that future evaluations be conducted in Bremen, Germany at Kaffee Hag's pilot plant.

In April 1986, PM representatives visited the Bremen facility. A large cross-functional team was established consisting of members from PM R&D, PM Engineering, GF, FTR R&D, and the Bremen facility management. Extraction trials were conducted at Bremen during June and July 1986, again using carbon as the absorbent. Results of these trials were ~~disappointing~~^{not satisfactory} from a taste point of view. Apparently, too much non-nicotine materials were extracted ^{from the tobacco} and absorbed by the carbon.

The team returned to Bremen in September 1986 for additional trials. Various other materials were tried as absorbents for the extraction process. These materials included cellulose, cocoa shells, acidified paper, and tobacco stems.

³C. Lilly, H. Grubbs, D. Knudson and F. Utsch.

Could not generate enough tabs.

or was it ~~mono~~potassium Citrate??

che
of client

Various acidic materials, including ~~MAP~~ (monoammonium phosphate), were applied to the absorbents to increase the efficiency of extraction. Tobacco stems proved to be an excellent absorber because stems contain similar substances to those found in tobacco. That is, an equilibrium was established limiting the loss of many non-nicotine substances from tobacco. Based on the results of these trials, Philip Morris ^{USA} made the decision to build a supercritical CO₂ extraction pilot plant in the US in November 1986.

subjective, chemical and process

The team made another trip to Bremen in January 1987. Only tobacco stems were used as an absorber during these trials. Various types of tobaccos were extracted to evaluate their taste characteristics after processing.

From April through July 1987 another set of trials ^{were} run in Bremen. The purpose of these trials was to extract sufficient amounts of tobacco to accumulate a stock of extracted tobacco for product development work.

C. Early Concept Testing

Concept studies were conducted in 1983, 1985, and 1987. These studies were carried out to help Product Development determine consumer interest in new or novel cigarette ideas. In each of these studies, concepts describing cigarettes with low levels of tar and/or nicotine were tested. In each case, they were rated among the top in consumer interest. *All of these concepts also promised "good taste."*

In 1983 one of the top rated concepts was "an ultra-low tar version of a popular full-flavor brand." This cigarette was described as having the same basic flavor as the parent brand, but would be milder with reduced levels of tar and nicotine. In

1985, the concept of "nicotine free" was added. This concept was revised in 1987 to be "95% nicotine removed." This cigarette was described as "made from special tobacco to give a good tasting smoke without nicotine". Also in 1987, the concept of a cigarette with equal nicotine and "95% of the tar removed" was tested. In all cases, promises of reduced tar and/or nicotine levels were rated highly by the consumer.

D. Decision to Commercialize

Based upon favorable subjective evaluations using stems as an absorber during the September 1986 trials in Bremen, the decision was made to evaluate the commercial feasibility of a supercritical CO₂ tobacco extraction facility. Engineering work began in 1986 on the design and construction of a commercial facility capable of producing alkaloid reduced filler to support a^{potential} market of 12 billion cigarettes per year. *Foot note → A 2% share of the US market.*

The ART⁴ Pilot Plant came on-line in August 1987. The first series of pilot plant trials focused on design issues for the commercial plant. Pilot plant priorities *gradually* ~~quickly~~ shifted toward supporting product development work to meet the program goals of a 97% nicotine extracted product with liking scores better than Doral.

Marketing began developing programs for a reduced nicotine cigarette to be launched in the first half of 1989. Product development work had advanced to a point where it was felt that ~~an~~ ^{an} acceptable cigarette with 97% of the nicotine removed could be produced. Funds were approved in February 1988, to construct

alkaloid reduced tobacco
⁴ Note on terminology: "ART" was the original name for the program and was generally used to refer to the *process* for removing nicotine from tobacco. The term "De-Nic" was based on marketing plans and was generally used to refer to the *product* after extraction.

a commercial facility at the Bermuda Hundred site adjacent to Park 500. This facility came on-line in mid-1989.

The 1988 Surgeon General's Report added a sense of urgency to the ART program. It equated nicotine to "hard drugs" with respect to nicotine's alleged addictive properties.

II. PRODUCT AND PROCESS DEVELOPMENT

Process and product development began in earnest when the ART Pilot Plant came on-line in August 1987. A large cross-functional product development team was established with members from Product Development, Process Development, Analytical Research and other areas in R&D and Manufacturing. The development objectives were:

- Develop a commercial supercritical CO₂ process to remove 97% of the extractable nicotine from filler.
- Cost optimize the commercial process to maximize capacity and minimize cost while achieving the desired product objectives
- Optimize the commercial process to obtain the best possible subjective character from cigarettes produced with this filler.
- Develop products with subjective character equal to or better than price-value brands, such as Doral, from filler which has had 97% of its nicotine extracted with supercritical CO₂.

The ART process resulted in a dramatic change in the taste of the original tobacco. The type of tobacco chosen for extraction, the casing and flavors used, and cigarette construction also significantly affected the final subjective character of the cigarette. It was necessary for Process Development, Leaf, Flavor, and Cigarette Technology to work closely in making changes to any variable during the development cycle. A change to any one parameter could have substantial, and possibly adverse, effects on subjective character or process economics.

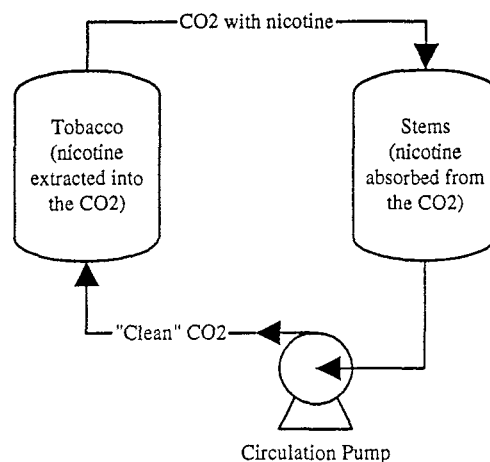
A. Process Development

The development program went through two distinct stages. In the first stage, the emphasis was on ^{determining process parameters for achieving} achieving the desired 97% nicotine extraction. This work resulted in a set of initial process specifications that was used as a design basis for the commercial facility. The second stage began after product testing indicated that the tobacco from this "best extraction" process had significant subjective ^{deficiencies} ~~problems~~. This latter work concentrated on modifying the extraction process in an attempt to improve the subjective character of the tobacco while still achieving the desired extraction.

1. Initial Process

The ART process works by recirculating supercritical CO₂ through a bed of tobacco. Nicotine is extracted from the tobacco into the CO₂. For the process to work, however, a second material, the absorbent, is needed to remove, or

ART Process



“scrub”, the nicotine ~~back out of the~~ ^{from the} CO₂ so that the CO₂ can pick up additional nicotine on its next pass through the tobacco bed. The key to the process is thus to enhance both the extraction of nicotine from the tobacco as well as the absorption of nicotine into the absorbent. The overall extraction efficiency of the process is influenced by both of these steps.

Ideally, only nicotine would be extracted from the tobacco; nothing else. Supercritical CO₂ approached that ideal process although some substances other than nicotine were extracted.⁵ As a result, the process development not only had to concentrate on nicotine extraction, but also on the selectivity of the process for removing nicotine with minimal extraction of other tobacco components. It was felt that this would produce the best subjective ~~the~~ product. Process testing determined that there were six process parameters that influenced the extraction.

Higher *extraction pressure* increases the rate of nicotine extraction from the tobacco. The Bremen trials had used 3,800 psi, and this was initially selected as the process specification. Higher *extraction temperature* also increases the nicotine extraction rate. While the Bremen trials had used 140°F, early testing indicated that temperatures as low as 130°F could still achieve extraction targets.

Although the process was very efficient at extracting nicotine from tobacco, it was apparent, even from the Bremen trials, that additives would be necessary to enhance the extraction efficiency. Increasing the *tobacco pH* increased the solubility of nicotine in CO₂. A pre-extraction casing was developed for the

⁵See Appendix 1.

tobacco that contained ammonium bicarbonate (AB), initially at an add-on rate of 3% of the tobacco weight on a dry weight basis. While the AB was successful in improving extraction, it was realized that the residual ammonia resulted in substantial off-taste problems. It was initially hoped that these problems could be rectified by further tobacco processing.

Just as higher pH enhanced the solubility of nicotine in CO₂, a lower *stem pH* helped to scrub the nicotine onto the absorbent. To lower the stem pH, monopotassium citrate (MPC), at an add-on rate of 12% of the stem weight on a dry weight basis, was initially used for this purpose.

Longer *extraction time* also increases the nicotine extraction. The length of extraction was defined not in time, but rather in the number of pounds of CO₂ that was circulated through the tobacco bed per pound of tobacco. This was referred to as "M/M" (M-over-M). While the other parameters were rigidly specified, the facility could vary M/M as needed to achieve the target 97% extraction of nicotine. At the conditions specified above, testing in the pilot plant showed that M/M as low as 150 could achieve this target. Obviously, lower M/M was desirable in order to increase the capacity of the plant.

A final parameter was the *stem-to-filler ratio*. The process required that there be enough stems to "hold" all the nicotine extracted from the tobacco. This establishes a minimum stem-to-filler ratio, which was found to be 1 pound of stem per pound of filler.

In summary, the initial process conditions were 3,800 psi, 130°F, 3% AB add-on to the filler, 12% MPC add-on to the stems, about 125 M/M, and a 1 to 1 stem-to-filler ratio.

2. Process Modifications to Improve Subjectives

The conditions described above were developed primarily to optimize the nicotine extraction efficiency. However, evaluations of the pilot plant material showed significant subjective problems, which were also seen with the initial samples from the commercial facility. Process development activities shifted to a second stage in attempts to remedy these problems. As a result, all six of the process parameters listed above were changed.

The first major problem to be addressed was the off-taste in the product. Post-extraction treatments of the tobacco with various acidic materials, flavor materials, and steam were unsuccessful in eliminating this off-taste. Since the residual ammonia was a contributor to the off-taste, the AB add-on target was reduced from 3.0% to 2.5%. This resulted in some taste improvement, but the residual ammonia from the AB was always felt to be somewhat responsible for the off-taste of the De-Nic product. Reducing the AB add-on resulted in some loss of nicotine extraction efficiency.

The second major change was the reduction of the extraction pressure from 3,800 psi to 2,000 psi. Initial tests in the commercial facility showed that ~~we~~ ~~it~~ ~~were~~ extracting more non-nicotine materials than previously thought. Subsequent tests showed that the reduction in extracting pressure improved the selectivity of the process to some extent. While the absolute extraction rate of

nicotine was reduced, the rates for the non-nicotine materials were reduced to a greater extent. This change in extraction pressure resulted in some improvement in subjective character.

Both the AB reduction and extraction pressure reduction decreased the rate and efficiency of nicotine extraction, however. This required changes in the other process parameters to compensate and still achieve the 97% target. The extraction temperature was increased back to 140°F, and the M/M ratio was also increased to 175. Further, the extraction pressure reduction changed the density and flow properties of the CO₂ such that the recirculation rate had to be lower as well, which extended the absolute extraction time even further. All of these changes were undesirable from a cost and plant capacity viewpoint, but the severity of the subjective problems left no other alternatives.

A change was also made to the stem absorbent to improve its scrubbing efficiency. The MPC was replaced by citric acid (CA) to further reduce the stem pH. Because CA was more effective, the add-on rate was decreased to 8%, and the stem-to-filler ratio was reduced to 0.75 pounds stem per pound filler.

This second set of process conditions was developed over the latter half of 1989. In summary, these conditions were 2,000 psi, 140°F, 2.5% AB add-on to the filler, 8% CA add-on to the stems, 175 M/M, and a 0.75 stem-to-filler ratio. These specifications were officially adopted in early 1990 and used for all subsequent products.

3. Later Process Development

If De-Nic sales volume ever approached plant capacity, we would not have been able to acquire enough stems to use as an absorbent. Consequently, process development activities in the pilot plant facility for the remainder of the program focused on developing a second generation extraction process, where a water and citric solution acid would be used as the absorbent, not stems. This process, while successful in eliminating the stems, had no effect on product subjectives and was not implemented in the commercial facility because sales volume did not justify the additional capital expenditure.

B. Product Development

Significant product development activities were associated with providing direction to the process development effort described in the previous section. In addition, there were other initiatives that did not directly affect the extraction process parameters.

1. Tobacco Blend

Extraction trials at the ART Pilot Plant were used to develop tobacco blends. Individual blend components, typically single grades of tobacco, were extracted and subjectively evaluated. Based on these subjective evaluations and availability of leaf, the DL Blend was developed.⁶ The DL blend was used in the first four De-Nic test markets in mid-1989.⁷

⁶DL Blend: DL-Bright - 68.6%; DL-Burley - 19.6% (Bodied and thin); MT-Oriental - 11.8%
⁷1989 De-Nic Test Markets; NEXT: Omaha, Nebraska; Hartford, Connecticut; Toledo, Ohio; Merit De-Nic- Spokane, Washington.

DL stands for Design Lamina

In 1990, after the new low pressure extraction conditions were selected, blend work was re-initiated. Using low pressure extraction conditions, single grades of tobacco were again extracted and subjectively evaluated. Based on these results, various blends were developed, extracted and subjectively evaluated. As a result Blend 215 was chosen for the low pressure extractions.⁸ Blend 215 was used for the Phoenix and Tampa test markets and the other existing test markets were converted to 215.

2. Flavors and Menthol

Flavors and casing systems are used to add pack aroma to the product, modify the taste direction of the product slightly and add the characteristic "Brand Signature". *Flavors cannot make a bad product good or cover up major subjective deficiencies within a product.*

*the tobacco,
a cigarette*

The key challenge in developing a flavor system for De-Nic products was overcoming the inherent off-taste in the product. Development efforts concentrated on masking or eliminating this taste and adding "tobacco-like" response to the product. Various post-extraction casing and flavor systems were evaluated for this program. Hundreds of individual flavors and flavors systems were subjectively evaluated on a laboratory, pilot and commercial scale. Unfortunately, particularly for the non-menthol version, we were never able to overcome the off-taste problem.

I'd like to include the reference to Capsaicin. It came up in the workshop as a possible substitute for nicotine!

Development of the menthol prototypes achieved ~~some~~ ^{a higher} level of success. Menthol has the ability to "cover-up" some amount of off-taste. Menthol, like

to read

⁸215-Blend; DL-Bright - 65%; 215-Burley - 25% (Bodied); MT-Oriental - 10%.

nicotine, has a trigeminal sensorial response which may have contributed to higher liking scores by internal panels compared to the non-menthol version.

C. Consumer Testing in Support of Product Development

1. Internal Testing

All of the initial product testing of De-Nic was performed within R&D using PM smokers. This was done solely to prevent competitors from gaining knowledge of our program. We were fully aware of the limitations associated with testing products internally. Market acceptance of the products tested could not be ~~addressed~~ ^{quantified} with internal panels because of the small number of smokers and the variety of brands and deliveries that were being evaluated. Product improvements could, however, be assessed through measuring differences from controls.⁹

Sensory research on De-Nic began in 1986 with a test conducted to determine the overall sensory effects of nicotine extraction on various types of tobacco. It was found that extracted tobaccos were perceived by our internal smokers as lower in impact¹⁰ and overall acceptability, and higher in off-taste. There were also fewer differences in taste attributes between types of tobacco after extraction. This implies that the extraction process was removing or modifying ~~taste~~ ^{The inherent flavor} components that were responsible for the individual character of the tobaccos.

⁹Controls refer to conventional cigarettes that have not undergone a nicotine extraction process.

¹⁰Impact can be defined as: Upon inhaling cigarette smoke, the primary sensation or response immediately felt in the back of the throat, typically short lived in duration and dissipates upon exhaling. Impact is followed by other sensations and flavor responses.

From the end of 1986 through 1987, the Bremen tests were conducted to explore different extraction processes and the overall effects of processing on taste. The processing changes that were sensorially evaluated included carbon versus citrate on stems as the absorbent, and the use of ammonium bicarbonate as a processing aid to increase the rate of extraction. All De-Nic cigarettes, regardless of the extraction method used, were rated higher than conventional cigarettes in unusual flavor, off-taste, and mouthcoating.

The overall taste effects of processing were evaluated by a series of nicotine add-back studies. This testing indicated that adding back the extracted nicotine improved sensory ratings somewhat, however, overall acceptability was still lower than controls. These samples were evaluated by internal expert smokers only. Other important ^{inherent} flavor components were also being lost or modified in the extraction process.

*with internal smoker
among who? was this internal?*

During this same time period (1986-1987), extended testing (over 5 packs) was conducted versus Doral Lights and Carlton. Doral Lights was chosen because it was considered to be one of the least acceptable cigarettes on the market, and Carlton was chosen because it was in the same nicotine range as De-Nic.

Testing of De-Nic showed a drop in acceptability from the first to the last cigarette in the first pack and leveling off thereafter to a similar acceptability rating to Carlton. Neither Carlton nor Doral Lights showed a similar drop over time. De-Nic was rated similar in acceptability to Carlton and lower than Doral Lights. Although De-Nic was rated higher in satisfaction than

Carlton, it was also rated higher in off-taste, mouthcoating, and non-tobacco taste indicating that these deficiencies were not due to low nicotine content. One extended test, with internal expert smokers, showed that while an extracted cigarette with nicotine added back was less acceptable than a control, the acceptability did not drop over time. This may indicate that the presence of tar without nicotine might result in an initially more positive impression with increasing dissatisfaction with the cigarette over time when nicotine is missing.

During 1988 and early 1989, a series of tests were conducted to evaluate blends and flavors in an attempt to minimize off-notes. Mentholated cigarettes were also investigated. While slight directional improvements were seen, flavorings were unable to compensate for off-notes. An exception to this was menthol. Mentholated De-Nic products showed higher initial acceptability ~~as~~ compared ^{to} with non-menthol De-Nic cigarettes; however, the same drop in acceptability from first to last cigarette in a pack was noted.

Further extended testing ^{amongst} conducted during this time period concluded that a subset of people liked and would continue to smoke a De-Nic product. This group could not be defined in terms of socio-demographic variables. ^{why? sample size}

In 1990 sensory research was focused on different absorption processes and adding back non-nicotine materials that had been lost through processing. While some subjective improvements were seen, the product was still significantly less acceptable than conventional cigarettes.

Why?
check in the
in text over

George, Ok
do you think this
Paragraph is
redundant?
your call

amongst internal smokers

In 1990 and 1991, two internal studies were conducted to determine the effects of tar, nicotine, and menthol on the attributes of strength and menthol perception. All three variables were found to interact to affect these attributes:

- In non-menthol cigarettes, higher levels of tar and nicotine produced higher strength perceptions. The strength correlation was better for nicotine than tar. Tar was more tightly correlated with off-taste than was nicotine.
- In menthol cigarettes, menthol added to the overall strength perception (second to nicotine). The perception of menthol was not affected by nicotine.

Why? Don't know?

This relationship was explored further using an external panel of smokers. In these tests, the tar and menthol were increased to a high enough level to compensate for the loss of strength in a reduced (one-half level) nicotine cigarette. The acceptability of these models was low, suggesting that an imbalance of tar and nicotine may lead to poor acceptability.

2. External POL Testing

^{A+}
During the end of 1989, large scale testing was begun on our external consumer panel. Each of these tests was conducted using over a thousand smokers representing the entire delivery range. The respondents were chosen from our established database (POL) composed of over 300,000 smokers across the United States. A series of monadic blind product tests were conducted on non-menthol cigarettes (85 and 100s) of different tar levels, extraction pressures, and with different blends and flavor systems.

All non-menthol tests showed results that were significantly lower in liking than cigarettes of equivalent tar levels. The De-Nic cigarettes were also found to be less acceptable than conventional cigarettes in the same nicotine range (Carlton, Now) as evaluated by smokers of low nicotine cigarettes. This was in agreement with results found internally indicating that extracted cigarettes had been altered in taste character over and above the loss of nicotine.

III. MARKETING

A. Small Scale Concept and Trial Testing

During January 1988, three focus groups were held in New York City to gauge interest in a De-Nic Merit product. Since the product was being tested as a Merit entry, interviews were held among one group of Merit smokers and two groups of competitive low tar smokers. Trial interest was high, primarily because of the product's perceived health benefit. However, respondents indicated that repurchase of the De-Nic product would depend on its ability to deliver good taste. Some respondents felt that the De-Nic product fit with Merit's low tar image. However, the association of good taste with the Merit name was only believed by current Merit smokers and a few competitive smokers. For most competitive smokers, the Merit name conveyed an unacceptable taste perception, and therefore they would reject a new Merit entry.

A nicotine Concept Test was run during February 1988. A total of 750 interviews were conducted among 18-54 years olds. Menthol and non-menthol smokers in 10

geographically dispersed markets were asked to assess four De-Nic concepts. The product concepts were:

- ◇ Nicotine Free
- ◇ Reduced Tar
- ◇ All Natural
- ◇ Less Visible Smoke

Of the four concepts tested, "Nicotine Free" and "Reduced Tar" appeared to have the greatest appeal to smokers, with one-third of the respondents expressing interest in each of these concepts. However, when those selecting "Nicotine Free" were told that there would be a taste sacrifice, interest in the product was reduced by more than half. The preference for "Nicotine Free" was based on the perceived health benefit. The disadvantage to this concept was that the taste would be compromised. Those smokers most interested in the "Nicotine Free" concept were: women, older, flavor low smokers, and ultra low non-menthol smokers. However, when smokers were informed there would be a taste sacrifice, there was less discrimination in appeal among smoker groups.

A series of focus groups and one-on-one interviews were conducted by Marketing Research in the fall of 1988 among flavor-low tar and ultra-low tar smokers.¹¹ These groups explored interest in the concept, initial reaction to the cigarette, and initial advertising direction. Consumers understood the concept and were generally interested in it. However, there was some degree of confusion about the

¹¹Flavor-low tar smokers are those smokers in the Lights category, i.e. smoking brands in the 8 to 11 mg tar range. Ultra-low tar smokers are those smokers in the Ultra-Lights category, i.e. smoking brands in the 5 to 6 mg tar range.

differences between low tar and low nicotine. Some respondents perceived low nicotine cigarettes as "healthier" and others considered them as a way to cut down on smoking. Although the taste was thought to be lighter than most people wanted, those that were interested in the concept expressed a willingness to adjust to it.

As part of the 1988 Continuous Tracking Study¹², two thousand smokers were asked a series of questions aimed at determining preference for either a nicotine free or tar reduced cigarette. Previous research evaluated four concepts and the results indicated that these two product concepts have the greatest appeal to consumers. Findings from this study were consistent with past findings. Specifically, the two concepts seemed to have equal consumer appeal with about half of all respondents preferring nicotine free and half preferring reduced tar. Interest dropped, however, when respondents were informed that they would have to make a taste compromise.

In January 1989, R&D conducted sixty-nine one-on-one interviews among flavor-low tar and ultra-low tar smokers. This research was designed to evaluate concept interest and initial cigarette acceptability in the context of a free-standing product named Next. Four and eight mg tar products were used in the study. Again, the concept was favorably received.

In the spring of 1989, concept/trial protocols were expanded to include more product usage. This research explored concept interest, single stick smoking (initial reaction to the product), and 2 pack placement with call-back followed by a

¹²Continuous Tracking Study: A telephone study conducted among 3,000 smokers per month to track current brand, alternate cigarette purchases, coupon usage and other brand information.

product choice (carton of own or carton of De-Nic).¹³ As in the internal studies, liking ratings dropped from single stick to 2 packs. In general the menthol product performed better than the non-menthol product. When offered a carton of own brand versus De-Nic, 25% of the non-menthol consumers chose De-Nic, versus 45% among menthol smokers.

B. Large Scale Consumer Use Testing

In July 1989, extended use testing was conducted by Marketing Research on a nationally representative sample of smokers (~4000). Consumers were sent up to three cartons, and were interviewed up to three times during the study. This research was conducted to determine long term appeal, to profile interested smokers, and to identify which packings had the greatest appeal. Sixty percent of the smokers initially contacted were interested in trying De-Nic. In long term smoking among consumers interested in the proposition, liking ratings improved over time. This indicates that interested consumers can adjust to the taste somewhat. At the end of the study, approximately 10% of the respondents rated De-Nic as excellent and expressed an interest to use it in place of their regular brand. This subgroup was identified as the intended audience. From this research the products with highest appeal were regular and menthol, flavor-low and ultra-low 100 mm.

Two POLs were conducted in March through June of 1989. These studies included blind product testing of three De-Nic models (at 4, 8 and 11 mg of tar),

¹³In this research each potential consumer (panelist) is shown a product concept statement and asked to rate their potential interest in that type of a product. Then the panelist is given a single cigarette to smoke and asked to rate it on liking. Next the panelist is given two packs of cigarettes to take with them and smoke at their leisure. The panelist is contact by phone several days later, asked to rate the two packs on liking, then asked a hypothetical product choice question: Would you like a carton of your own current brand or a carton of De-Nic?

followed by telephone call-back. During this call-back the panelists were read a concept statement describing the test cigarettes they had smoked. The panelists were then offered a carton of De-Nic or their own brand. The panelists were then re-contacted and offered the carton choice again. Results showed that most consumers were interested in the De-Nic concept and that a segment (~17%) liked and continued to choose the De-Nic over their regular brand.

As previously found through internal and small scale concept/trial studies, both of these consumer studies identified a subgroup of smokers that liked and would continue to smoke a De-Nic product. These smokers were more likely to be female, over 30 years old, and consumers of 100mm ultra-low tar menthol cigarettes.

C. Ad-Pack Tests

1. Nicotine-Extracted Advertising/Single Cigarette Study - January 1989

This study was conducted among 300 non-menthol smokers' to assess opinions and reactions to De-Nic products and advertising. The total sample was divided into three groups:

- ◆ One third was shown a "N-ext" ad and given a control Merit cigarette to smoke.
- ◆ One third was shown a "N-ext" ad and given a nicotine extracted product to smoke.
- ◆ One third was shown a "Merit Free" ad and given a nicotine extracted product to smoke.

Jimma questioned the spelling. Was this an actual ad? Fix if necessary.

Reactions to ads were assessed prior to respondents smoking the product. The respondents were given one stick to smoke and reactions were obtained. Key Findings of this study were:

- All of the ads effectively communicated the product proposition. Respondents shown the Merit Free ad more frequently mentioned lower nicotine while respondents in the group exposed to the N-ext ad and receiving De-Nic product were more likely to mention "Nicotine Extracted" more than respondents in the other two groups.
- Most respondents across the groups thought the product would be different than other major brands after viewing the ads and about half in each group thought this difference was extremely or very important. The primary reason attributed to this importance was the lower nicotine.

2. Ad/Pack Research - March 1989

An Ad/Pack was conducted among 1,778 flavor low and ultra low, non-menthol and menthol smokers to evaluate interest in two De-Nic concepts: Merit Free and Next.

Respondents were shown advertising and then given five packs to take home. Call backs were made after smoking two packs and then after smoking five packs. Respondents were then presented with a hypothetical situation of choosing a free carton of the De-Nic product or a free carton of their regular brand to further assess interest. Key findings of this study were:

- Overall, prior to smoking the product, purchase interest based on the concept was low.¹⁴ After smoking two packs of the De-Nic product, purchase interest decreased.
- No difference was found in purchase interest or opinion of taste after two packs between Merit Free and Next.

D. Test Markets

Below is a summary of the shipment and retail performance of De-Nic in its various test markets and brand presentations. A brief recap of Merit Ultima's year 1 performance is also included for comparison.

1. Next De-Nic - Original Test Markets

Next De-Nic was tested in three different packing configurations, in three markets, beginning July 1989.¹⁵ Retail shares reached highs of 1.3 to 2.7 share points in the first two months. Typically, 40 - 50% of volume consisted of '2 for the price of 1', and '5 for the price of 2' deals. In general, the higher the deal product offers, the higher the peak shares.

All markets peaked within two months and then showed consistent declines. In month three, shipment shares to our direct customers dropped below 0.1 to 0.2 share points, and, except for one brief surge to 0.35 share points in Toledo, remained there.

These ¹⁴In this Ad/Pack test the respondents were rating purchase interest based on the Merit Free and Next ads. This differ from previous concept research where the consumers were just given a concept without a name, pack, or imagery.

¹⁵Omaha, Nebraska - Ultra low product; Hartford, Connecticut - Flavor low product; Toledo, Ohio - Ultra and Flavor low products.

2. Merit De-Nic

Merit De-Nic's test market began in August 1989, one month after the original Next markets. Like the Next test markets, peak retail share of 1.6 share points was achieved in the first two months. Promotional offers were identical to the Next test markets. Also similar to the Next test markets, Merit De-Nic's shipments dropped to near 0.1 share of market after twelve weeks.

3. Next De-Nic -- Tampa Test Market

After poor showings in the original test markets, a modified product was introduced into the Tampa market in May 1990. Promotional retail support was extended longer than in the original markets, and was augmented by direct mail offers. Relatively higher retail shares were sustained into month three, with about one third of the brand's volume consisting of retail promotional product in the form of '2 for the price of 1' deals. Nevertheless, after about seven months, shipment shares had dropped to the 0.1 - 0.2 range. By the end of the year 1, they dropped to below 0.1 share points.

4. B&H De-Nic -- Arizona Test Market

The final De-Nic product tested at retail was B&H De-Nic, which began in October 1990. Retail shares built slower and peaked somewhat later than in other markets. Share built to 1.7 share points in months three and four. Except for the timing of the peak shares, ongoing tracking indicated that B&H De-Nic was not performing significantly differently from those earlier markets. Retail promotion product, in the form of '2 for the price of 1', comprised about

30% of the brand's total retail volume during the first four months. By month eight, shipment shares had dropped to 0.2.

E. Merit Ultima Performance in National Launch

~~Merit Ultima was launched the first quarter of 1992. By the end of the year, national retail shares, as measured by PM's integrated Nielsen monthly panel, were in the 0.4-0.5 share point range. Shipment shares were averaging about 0.3 share points.~~

Can we add an introductory sent.?

add a sentence: Retailers & Wholesalers were complaining about the slow moving product & were asking to return product,

V. DECISION TO PULL THE PRODUCT

Shipment share in all the De-Nic test markets had dropped to a level of 0.1 to 0.2, and in the case of Tampa to below 0.1 share points. In addition, incidence of stores who used to, but no longer carry the product was increasing. This data, taken together, indicates that the demand for this product is dropping; the consumers are not pulling it through retail.

Does this work?

De-Nic Products were produced in a dedicated production facility. With Shipment Share at 0.1 to 0.2 level, this facility was idle most of the time. Facing decreasing share and high operating costs for an idle facility, the obvious business decision was made to shut the facility and pull the product from test market.

By way of comparison, Merit ultima BT's (1mg tar, 0.1mg nicotine) and 100's (2mg tar & 0.2mg nicotine) were bunched to compete with Carlton & new in the first quarter of 1992

Can we make a closing statement about work continuing until on a new product version and export versions?

Appendix 1

What Else Besides Nicotine Was Extracted?

In addition to nicotine, the following compounds or compound classes have been reported as detected either in samples of the supercritical carbon dioxide used to extract the tobacco, from the liquid carbon dioxide that was stored in the working vessel, or from laboratory scale experiments. It is important to realize that the temperature and pressure used for the extraction changes the distribution of the compounds that are extracted. When possible, the comments below pertain to the extraction conditions (2200 psi) that were used near the close of the ART Program.

OILS AND WAXES: The generic terms of oils and waxes cover a number of compound classes and a larger number of specific compounds. These compounds are extracted by supercritical carbon dioxide. At the risk of over simplification, and with recognition of exceptions, these compounds (especially those of higher molecular weight) become more soluble in supercritical fluid carbon dioxide as the pressure and temperature increase. In a way analogous to essential oils in other plants such as citrus fruit, the presence and balance of these compounds in tobacco give it the characteristic flavor and aroma that is associated with tobacco. Removal of these compounds, or even a change in the concentration ratios, can destroy the characteristic flavor or aroma of the plant. As the ART Program progressed, movement from the ~~stringent~~ extraction conditions to milder ones had a subjective impact.

positive

most effective

ISOPRENOIDS: Isoprenoids are a class of compounds that are acyclic terpenes derived from isoprene that are tobacco specific. Two of these are commonly associated with tobacco. They are solanesol and neophytadiene. Neophytadiene is normally the most

abundant compound present in the mass spectrum of samples taken from the extraction fluid, and in laboratory scale extractions. Solanesol is of much larger molecular weight than neophytadiene. Although evidence of solanesol in the extraction fluid was found, it was not confirmed by standard analytical methods. The solubility of solanesol in the supercritical fluid would be significantly dependent on the temperature and pressure.

CARBOXYLIC ACIDS: Tobacco contains a number of carboxylic acids. The lower molecular weight acids are perhaps too polar to be soluble in supercritical carbon dioxide. However palmitic acid, oleic acid, and a number of C₁₈-fatty acids were found in samples taken from the extraction fluid. The impact of these compounds on flavor considerations is not well understood.

HYDROCARBONS: A series of hydrocarbons in the range C₂₇H₅₀ to C₃₃H₆₈ was found in the extraction fluid. A compound in this range that also contained aromatic as well as aliphatic character was detected but not identified. These compounds are of a nature to expect extraction by supercritical carbon dioxide. The impact of removal of these compounds on tobacco flavor and aroma is not known.

TOBACCO-SPECIFIC NITROSAMINES: Various fillers that had been extracted with supercritical carbon dioxide were analyzed for tobacco-specific nitrosamine (TSNA) content. TSNA levels of the extracted fillers were reduced relative to controls that had not been extracted.

OTHER COMPOUNDS: Other compounds that have been detected or suspected include cembranoids, stigmaterol. These compounds are known to be in tobacco and cembranoids have been reported to effect the "quality" of cigarette smoke.

COMPOUNDS NOT EXTRACTED: Two classes of components not found in the extraction fluid are sugars and inorganic compounds. Although sugars are known to impact flavor, they alone are not sufficient to provide the necessary aroma and flavor for good subjective response.

Advertising Claims

Appendix 2

1. Introducing De-Nicotined Tobacco With Rich Flavor.; Thanks to our patented FreePLUS process, it is now possible to naturally remove nicotine from fine tobaccos while leaving their rich flavor intact.; As a result, our new cigarette has less than 0.1 mg nicotine.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.
2. De-Nicotined Tobacco the Smooth Taste of a Light.; The only cigarette with less than 0.1 mg of nicotine made from de-nicotined tobacco.; It's a unique process that works much the way that caffeine is extracted naturally from coffee beans.; Nicotine extracted from fine tobaccos, creating a cigarette with a smooth, light taste and less than 0.1 mg nicotine.
3. De-Nicotined Tobacco the Smooth Taste of a Light; The only cigarette made from de-nicotined tobacco. So there's less than 0.1 mg of nicotine.
4. De-Nicotined Tobacco Retains Rich Flavor.; One-of-a-kind cigarette gives smokers unique option with less than 0.1 mg nicotine.; Our FreePLUS process now makes it possible to naturally remove nicotine from fine tobaccos while leaving their rich flavor intact.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.
5. De-Nicotined Tobacco.; Only one-of-a-kind NEXT offers smokers rich flavor with less than 0.1 mg nicotine.; That's because only NEXT is made with the patented FreePLUS process, which naturally extracts nicotine from tobacco, leaving rich flavor intact.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.

6. De-Nicotined Tobacco the Smooth Taste of a Light.; The only one that removes nicotine directly from the tobacco. So there's less than 0.1 mg of nicotine.
7. Introducing De-nicotined Tobacco with Rich Flavor.; Smokers now have an important option that offers rich flavor and less than 0.1 mg nicotine.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.
8. De-nicotined Tobacco.; The only cigarette with less than 0.1 mg of nicotine made from de-nicotined tobacco.; It's a unique process that works much the way that caffeine is extracted naturally from coffee beans.
9. Introducing De-Nicotined Tobacco with Rich Flavor.; Thanks to our patented FreePLUS process, it is now possible to naturally remove nicotine from fine tobaccos while leaving their rich flavor intact.; As a result, our new cigarette has less than 0.1 mg nicotine.; De-nicotined tobacco and rich flavor in a cigarette you'll like to smoke.
10. De-Nicotined tobacco with rich flavor, or de-nicotined tobacco with menthol refreshment.; Naturally extracts nicotine from tobaccos leaving rich flavor and less than 0.1 mg nicotine.
11. Introducing De-Nicotined Tobacco with Rich Flavor.; Starting today, there's only one option for smokers who want rich flavor with less than 0.1 mg nicotine.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.; For the first time, you can now enjoy menthol freshness and less than 0.1 mg nicotine in a cigarette made with de-

nicotined tobacco.; De-nicotined tobacco with menthol freshness in a cigarette you'll enjoy.

12. This Changes Everything.; New cigarette with de-nicotined tobacco and rich flavor gives smokers major reason to change.; NEXT is made possible by the patented FreePLUS process, which naturally extracts nicotine from fine tobaccos, leaving their rich flavor intact.; The result is a satisfying cigarette with less than 0.1 mg nicotine.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.

13. US Patent 4,153.063.; The patent is for the process. The FreePLUS process. The process that naturally extracts nicotine from tobacco, yet leaves rich flavor where it should be.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.

14. De-nicotined Tobacco and Rich Flavor are waiting for you right now.; With rich flavor and less than 0.1 mg nicotine.

15. The first cigarette with de-nicotined tobacco and rich flavor is coming.; Thanks to a patented Philip Morris process called FreePLUS it is now possible to naturally remove nicotine from tobacco without removing all the flavor.; It's because of this process that our rich de-nicotined tobaccos stay rich, even though less than 0.1 mg nicotine remains.

16. De-nicotined Menthol and Smooth Fresh Taste.; The result of a nicotine extraction process that remove nicotine directly from the tobacco itself. Much the way caffeine is naturally removed from coffee beans.; What you get is a smokeable menthol cigarette with smooth, fresh taste and less than 0.1 mg of nicotine.

17. De-nicotined tobacco the smooth taste of a light.; The result of a nicotine extraction process that removes nicotine directly from the tobacco itself. Much the way caffeine is naturally removed from coffee beans. What you get is a smokeable cigarette with the smooth taste of a light and less than 0.1 mg of nicotine.

18. De-Nicotined Tobacco the Smooth Taste of a Light.; Benson & Hedges De-Nic is the only cigarette with less than 0.1 mg of nicotine made from de-nicotined tobacco.; The result of a unique process that works much the way caffeine is naturally extracted from coffee beans, for a smokeable cigarette, with the smooth taste of a light.

19. Less than 0.1 mg nicotine the smooth taste of a light.; Benson & Hedges De-Nic is the only cigarette with less than 0.1 mg of nicotine made from de-nicotined tobacco.; The result of a unique process that works much the way caffeine is naturally extracted from coffee beans.

20. Rich Tobacco De-Nicotined is still rich tobacco.; As a result of our patented FreePLUS process, there is only one option for smokers who want rich flavor and less than 0.1 mg nicotine.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.

21. Introducing De-Nicotined Tobacco with Rich Flavor.; Smokers now have important new option from Merit that offers rich flavor and less than 0.1 mg nicotine.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.

22. Next De-Nic.; Smokers who enjoy rich flavor can take pleasure in a new cigarette with less than 0.1 mg nicotine.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.
23. Rich Tobacco De-Nicotined is still Rich Tobacco.; Breakthrough new cigarette with less than 0.1 mg nicotine keeps rich flavor intact.; Our patented FreePLUS process naturally extracts nicotine from fine tobaccos, without extracting flavor.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.
24. Menthol freshness stands out in NEXT De-Nic.; Our patented FreePLUS process new makes it possible to naturally remove nicotine from fine tobaccos.; As a result, our new cigarette has less than 0.1 mg nicotine.; De-nicotined tobacco with menthol freshness in a cigarette you'll enjoy.
25. NEXT De-Nic.; NEXT is made possible by the patented FreePLUS process, which naturally extracts nicotine from fine tobaccos, leaving their rich flavor intact.; The result is a satisfying cigarette with less than 0.1 mg nicotine.; De-nicotined tobacco and rich flavor in a cigarette you'll enjoy.
26. NEXT De-Nic.; The new is less than 0.1 mg nicotine. The first one made with de-nicotined tobacco and real menthol freshness.; Made possible by a patented process called FreePLUS that naturally extracts nicotine from tobacco.; De-nicotined tobacco with menthol freshness in a cigarette you'll enjoy.