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DOCUMENT 56

FINAL REPORT
Epidemiology, 220-3W-05
Medical Department
3M Company
St. Paul, MN 55144

Date: October 11, 2001

Title: A Cross-sectional Analysis of Serum Perfluorooctanesulfonate (PFOS) and Perfluorooctanoate (PFOA) in Relation to Clinical Chemistry, Thyroid Hormone, Hematology and Urinalysis Results from Male and Female Employee Participants of the 2000 Antwerp and Decatur Fluorochemical Medical Surveillance Program

Study
Start Date: March 1, 2000

Protocol Number (not applicable)
IRB Approval

Exempt	Expedited
X	

IRB Approval Date: (not applicable as these data are from a medical surveillance program)

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ABSTRACT

The 3M fluorochemical medical surveillance program is conducted on a routine periodic basis at the company's Antwerp (Belgium) and Decatur (Alabama) fluorochemical manufacturing plants. In the most recent occurrence in 2000, there were 255 Antwerp employees (206 male and 49 female) and 263 Decatur employees (215 male, 48 female) who participated in the program. This represents approximately 75 percent and 50 percent of the eligible employees at these two locations, respectively. Seventy three percent of the participating Antwerp male employees and 75 percent of the Decatur employees were engaged in production activities. Only 12 percent of the participating Antwerp female employees were engaged in production activities compared to 63 percent of the Decatur female employees.

Employees' sera were quantitatively analyzed for PFOS (perfluorooctanesulfonate), PFOA (perfluorooctanoate), PFHS (perfluorohexanesulfonate), PFOSAA (N-ethyl perfluorooctanesulfonamidoacetate), M570 (N-methyl perfluorooctanesulfonamidoacetate), PFOSA (perfluorooctanesulfonateamide) and M556 (perfluorooctanesulfonamidoacetate) using high-pressure liquid chromatography/electrospray tandem mass spectrometry (HPLC/ESMSMS) and evaluated versus an extracted curve from a human serum matrix. A total organic fluorine index (TOF) was also determined by calculating the percent of each specific fluorochemical's molecular weight that was attributed to organic fluorine and multiplied by the ppm measured for each fluorochemical and then summed across all seven fluorochemicals.

Mean serum PFOS levels for Antwerp production and non-production male workers were 1.16 and 0.42 ppm, respectively. Among Decatur production and non-production male workers, their mean serum PFOS levels were 1.63 and 0.73 ppm, respectively. Mean serum PFOA levels for Antwerp male production and non-production workers were 1.28 and 0.34 ppm, respectively. Among Decatur male production and non-production workers, their mean serum PFOA levels were 2.34 and 0.59 ppm, respectively. The mean PFOS and PFOA levels for the Antwerp female employees (primarily nonproduction) were 0.13 ppm and 0.07 ppm, respectively. The mean PFOS and PFOA levels for Decatur female production and nonproduction employees were 0.93 and 1.23 ppm, respectively. Separate reports have been written which analyzed the employees' serum levels in relation to their job and building location work assignments as obtained from a self-reported work history questionnaire.

A standard set of hematological and clinical chemistry tests were analyzed. These included the following hematological tests: hematocrit (percent), hemoglobin (gm/dl), red blood cells (RBC, 1000/mm^3), white blood cells (WBC, 1000/ mm^3) and platelet count (1000/ mm^3); and the following clinical chemistry tests: alkaline phosphatase (IU/L), gamma glutamyl transferase (GGT, IU/L), aspartate aminotransferase (AST, IU/L), alanine aminotransferase (ALT, IU/L), total and direct bilirubin (mg/dl), blood urea nitrogen (BUN, mg/dl), serum creatinine (mg/dl), blood glucose (mg/dl), cholesterol (mg/dl), high density cholesterol (HDL, mg/dl) and triglycerides (mg/dl). Urinalyses were only assessed for Decatur employees via the standard urine microstick analysis, which tested for urine glucose, albumin and red blood cells. Six thyroid hormones were also assayed: thyroid stimulating hormone (TSH; μIU/ml); serum thyroxine (T4; μg/dL);

free thyroxine (free T4; ng/dL); serum triiodothyronine (T3; pg/mL); thyroid hormone binding ratio (THBR, %, previously referred to as T3 Uptake) and free thyroxine index (FTI).

Statistical analyses were conducted on the entire surveillance population as well as subgroups by gender, production worker (yes/no) and location. Univariate analyses categorized mean levels by serum PFOS quartile distributions. Multivariable regression was used to analyze the clinical chemistry and thyroid hormones as dependent variables in relation to the independent effects of PFOS, PFOA or TOF adjusted for several demographic variables (age, body mass index, number of alcoholic drinks per day, cigarettes smoked per day and years worked).

There was a modest positive association between PFOS or PFOA with cholesterol as well as a stronger positive association between PFOA and triglycerides. These associations are inconsistent with the known toxicological evidence that has shown the hypolipidemic (not hyperlipidemic) effect of PFOS (in rats and primates) and PFOA (in rats but no effect in primates) at dosages that produced serum PFOS or PFOA levels higher than those measured in this population. Therefore, it is unlikely the observed positive associations between PFOS or PFOA and lipids are causal. Because of the potential confounding positive association with serum triglycerides, this variable was added to the hepatic clinical chemistry models as an independent variable. In these models, no significant associations were observed with PFOS, PFOA or TOF in relation to alkaline phosphatase, GGT, AST, ALT or total bilirubin. Although T3 was positively associated with PFOA, no other thyroid hormones were associated with PFOS, PFOA or TOF; thus there is unlikely a causal explanation (e.g., hypothyroidism or

hyperthyroidism) for this positive T3 association with PFOA. Hematological and urinalysis results were unremarkable.

In summary, the findings from the 2000 fluorochemical medical surveillance program continue to suggest that Antwerp and Decatur fluorochemical production and non-production employees do not have significant changes in serum cholesterol, lipoproteins or hepatic enzymes that are consistent with toxicological findings in laboratory animals. Limitations of the study include its cross-sectional design, the voluntary participation rates and the lower levels of serum PFOS and PFOA measured among these employees compared with those suspected to cause effects in laboratory animals. A longitudinal analysis is reported separately for the fluorochemical medical surveillance Antwerp and Decatur program data from 1994 through 2000.

INTRODUCTION

The 3M fluorochemical medical surveillance program is conducted on a routine periodic basis at the company's Antwerp (Belgium) and Decatur (Alabama) fluorochemical manufacturing plants. Prior to 1994, total organic fluorine was measured rather than any specific fluorochemical analyte. Serum perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) have been routinely assayed since 1994/95 rather than total organic fluorine. An analysis of the 1994/95 and 1997 medical surveillance program data in relation to Antwerp and Decatur employees' serum PFOS levels have been reported elsewhere (Olsen et al, 1998a, 1999a). In the 1994/1995 medical surveillance program, a total of 178 employees participated (Antwerp = 88; Decatur = 90) and 149 employees participated in 1997 (Antwerp = 65; Decatur = 84). A total of 61 Antwerp and Decatur employees participated in both years. The Antwerp male employee population was significantly younger than that at Decatur, had lower Body Mass Indices (BMI) and had higher self-reported daily consumption of alcohol. In addition, the employees' clinical chemistry profiles were different for several tests. The Antwerp employee population had lower mean alkaline phosphatase and triglyceride values and higher total bilirubin and HDL values than the Decatur employee population. The findings from this prior epidemiologic analysis suggested that significant clinical chemistry and hematological abnormalities were not associated with serum perfluorooctanesulfonate (PFOS) levels up to 6 parts per million (Olsen et al 1998a; 1999a). Nor were there consistent associations reported between serum PFOS and several hormone tests including testosterone, estradiol and thyroid stimulating hormone (TSH). It was not possible to derive inferences from the few employees who had serum

PFOS levels ≥ 6 ppm. An important limitation of this prior analysis was the low voluntary participation of male employees (less than 50%) and insufficient sample size of female employees which prevented a separate analysis. Also, although serum perfluorooctanoate (PFOA) was measured, it was not included in the analyses.

Because the voluntary nature of the medical surveillance program may not provide for a complete understanding of the distribution of serum fluorochemical levels in the Decatur workforce, a random sample of 232 employees was selected for fluorochemical testing in the Fall, 1998. The distributions of employee serum PFOS and PFOA levels were comparable to the results reported in the voluntary Decatur medical surveillance program (Olsen et al 1999b). This finding suggested that the distribution of serum fluorochemical levels observed in the prior voluntary medical surveillance program likely reflected the distribution of serum PFOS and PFOA levels of all employees in the chemical plant.

Detailed discussions of the toxicology and epidemiology of PFOS and PFOA have been reported elsewhere (3M Company 2000; Alexander 2001a; 2001b; Butenhoff et al 2001; Gilliland and Mandel 1993;1996; Haughom and Spydevold 1992; Olsen et al 1998a; 1998b; 1999a; 2000; Pastoor et al 1987; Seacat et al 2001a; 2001b; Sohlenius et al 1993). For the purpose of brevity, this information will not be summarized in this Introduction. Suffice it to mention that for the purpose of employee medical surveillance, PFOS has been reported to be an inducer of peroxisome proliferation and hypolipidemia in rodents (Pastoor et al 1987; Ikeda et al 1987; Haughom and Spydevold 1992; Seacat et al 2001a; Sohlenius et al 1993) and primates (Seacat et al 2001b). PFOA has been inconsistently reported to produce hypolipidemia in rodents (Pastoor et al 1987;

Haughom and Spydevold 1992;) and not in primates (Butenhoff et al 2001). The mechanism of action pertaining to this hypolipidemia remains to be fully elucidated.

The purpose of this report was to conduct a cross-sectional analysis of the 2000 fluorochemical medical surveillance program for Antwerp and Decatur male and female employees. Unlike the earlier report for Antwerp and Decatur employees which only analyzed for PFOS (Olsen et al 1998a; 1999a), the present study examined associations for both PFOS and/or PFOA as well as a calculated measure for total organic fluorine (TOF). Longitudinal analyses of employees who participated from 1994/95 through 2000 were not analyzed as this was a focus of a separate analytical report (Olsen et al 2001a).

METHODS

The fluorochemical medical surveillance program is available, on a voluntary basis, to all Antwerp and Decatur chemical plant employees and those site employees who may work in the chemical plant area. In 2000, approximately 340 Antwerp and 500 Decatur chemical plant and site employees were eligible to participate. In addition to the fluorochemical testing program, a standard battery of clinical chemistry, pulmonary function and urinalysis (Decatur only) tests were performed on employees. In addition, several thyroid hormones were measured. A site-specific work history was also administered to all employee participants. Analyses of these self-reported workplace questionnaire data in conjunction with the employees' serum fluorochemical levels have been reported elsewhere for Antwerp (Olsen et al 2001b) and Decatur (Olsen et al, 2001c).

Hematology, Clinical Chemistry and Urinalysis

Allina Laboratory Services (St. Paul, Minnesota) performed the standard hematological and clinical chemistry tests. These included the following hematological tests: hematocrit (percent), hemoglobin (gm/dl), red blood cells (RBC, 1000/mm^3), white blood cells (WBC, 1000/ mm^3) and platelet count (1000/ mm^3); and the following clinical chemistry tests: alkaline phosphatase (IU/L), gamma glutamyl transferase (GGT, IU/L), aspartate aminotransferase (AST, IU/L), alanine aminotransferase (ALT, IU/L); total and direct bilirubin (mg/dl), blood urea nitrogen (BUN, mg/dl), serum creatinine (mg/dl), blood glucose (mg/dl), cholesterol (mg/dl), high density cholesterol (HDL, mg/dl) and triglycerides (mg/dl). Urinalyses were only assessed for Decatur employees via the standard urine microstick analysis which tested for urine glucose, albumin and red blood cells.

Thyroid Hormones

Six thyroid tests were conducted by LabCorp (Kansas City, MO): thyroid stimulating hormone (TSH; μIU/ml); serum thyroxine (T4; μg/dL); free thyroxine (free T4; ng/dL); serum triiodothyronine (T3; pg/mL); thyroid hormone binding ratio (THBR, %, previously referred to as T3 Uptake) and free thyroxine index (FTI). TSH, free T4 and T3 were determined by an immunochemiluminometric assay (ICMA). T4 and THBR were determined by a cloned enzyme donor immunoassay (CEDIA). FTI was calculated by multiplying T4 and THBR.

Fluorochemical Analyses

Sera samples were extracted using an ion-pairing extraction procedure (Hansen et al, 2001). The extracts were quantitatively analyzed for PFOS (perfluorooctanesulfonate), PFOA (perfluorooctanoate), PFHS (perfluorohexanesulfonate), PFOSAA (N-ethyl perfluorooctanesulfonamidoacetate), M570 (N-methyl perfluorooctanesulfonamidoacetate), PFOSA (perfluorooctanesulfonateamide) and M556 (perfluorooctanesulfonamidoacetate) using high-pressure liquid chromatography/electrospray tandem mass spectrometry (HPLC/ESMSMS) and evaluated versus an extracted curve from a human serum matrix. Endogenous levels of certain fluorochemical were determined in the standard serum matrix and additional fluorochemical was spiked into the matrix. The total amount of each specific fluorochemical (endogenous + spiked) was used to construct an extracted standard curve. All serum fluorochemical analyses were determined by Northwest Bioanaltyical Laboratory Inc. (Salt Lake City, UT). A description of the distribution of the serum fluorochemical levels is reported elsewhere for Antwerp (Olsen et al, 2001b) and Decatur (Olsen et al, 2001c).

For Antwerp, all employee serum values for PFOS and PFOA values were above the lower limit of quantitation (LLOQ). There was one employee (0.3 percent) with a PFHS value below the LLOQ (0.0027 ppm) and one employee (0.3 percent) with a M570 below the LLOQ (0.0057 ppm). There were 111 employees (44 percent) with PFOSAA values below the LLOQ (0.006 ppm); 88 employees (35 percent) were below the LLOQ (0.001 ppm) for PFOSA; and 13 employees (5 percent) were below the LLOQ (0.0049

ppm) for M556. For Decatur, all employee serum values for PFOS, PFHS, PFOA and M570 were above the respective lower limit of quantitation (LLOQ). There were 8 (3 percent) employees with PFOSAA values below the LLOQ (0.006 ppm); 111 employees (42 percent) were below the LLOQ for PFOSA (0.001 ppm); and 13 employees (5 percent) were below the LLOQ for M556 (0.0043 ppm). For statistical analysis purposes, serum fluorochemical values that were less than the LLOQ were assumed to be the midpoint between zero and the LLOQ.

A total organic fluorine index (TOF) was determined by calculating the percent of each specific fluorochemical's molecular weight that was attributed to organic fluorine (PFOS (64.7%); PFHS (61.9%); PFOA (69.0%); PFOSAA (55.3%); PFOSA (64.7%); M570 (56.6%) and M556 (58.1%)) multiplied by the ppm measured for each fluorochemical and then summed across all seven fluorochemicals.

Data Analyses

Serum PFOS and PFOA levels were the predominant fluorochemicals as the other five analytes were measured at considerably lower levels (Olsen et al 2001b; 2001c); therefore, PFOS and PFOA were the only two specific fluorochemicals analyzed as explanatory variables in regression models. TOF was also considered in the analyses which took into account these other analytes in an aggregate index (see above definition). Descriptive simple and stratified analyses, Pearson correlation coefficients, ANOVA and multivariable regression were used to evaluate associations between PFOS, PFOA and TOF and each hematological and clinical chemistry test and thyroid hormone assay. For stratified analyses, employees were divided into quartiles of their serum PFOS

distribution. Age, body mass index, current alcohol consumption (drinks per day) and cigarette use (cigarettes smoked per day), years worked at Antwerp or Decatur, and type of job (production versus non-production) were potential confounding factors that were considered in the analyses. Production jobs included cell operators, chemical operators, mill operators and crew supervisors. Non-production jobs included engineers, QA/AC laboratory and research workers, secretaries and managers.

Multivariable regression models were fitted with PFOS and/or PFOA analyzed as a continuous variable(s). Natural log transformations of the dependent variables were performed, when necessary, to normalize variables and to enhance model fit. Study results were analyzed using the SAS System (1990).

RESULTS

Altogether, there were 255 Antwerp employees (206 male and 49 female) and 263 Decatur employees (215 male, 48 female) who participated in the 2000 fluorochemical medical surveillance program (Table 1). Seventy three percent of the Antwerp male employees and 75 percent of the Decatur employees worked in production activities. Only 12 percent of the Antwerp female employees worked in production activities compared to 63 percent of the Decatur female employees.

Provided in Table 2 are the mean PFOS, PFOA and TOF values, demographic values and clinical chemistry and thyroid values for male employees stratified by location and production or non-production work activities. Regardless of the production categorization, Antwerp male employees compared to Decatur employees had lower serum PFOS and PFOA levels; were significantly younger; had lower mean BMIs;

worked fewer years; drank, on average, more alcoholic beverages per day; had higher mean HDL and total bilirubin values; and had lower mean triglyceride, alkaline phosphatase, GGT, AST and ALT values. Mean thyroid hormone values tended to be higher among Antwerp employees. All mean values were within reference ranges. Comparable findings were observed for Antwerp female employees compared to Decatur female employees (Table 3).

Given the differences between Antwerp and Decatur employees, univariate analyses were initially stratified by location. Antwerp data, stratified by gender and production, are provided in Tables 4 through 12. In a similar fashion Decatur employee data are provided in Tables 13-24. The Decatur data also include employee urinalysis results.

Antwerp production male employee data (n = 150), stratified by quartile of serum PFOS distribution, is presented in three sequential tables for clinical chemistry (Table 4) and thyroid hormones (Table 5) and hematology (Table 6) results. The highest quartile (4th) mean serum PFOS level was 2.61 ppm (range 1.76 - 6.24 ppm) compared to the lowest quartile (1st) mean serum PFOS level of 0.29 ppm (range 0.04 - 0.41 ppm). Production workers in the highest quartile of serum PFOS levels were older and worked more years at Antwerp. There were no significant mean differences between the quartiles for BMI, cigarettes smoked or drinks per day. There was only one significant difference between the four quartile levels for any clinical chemistry, thyroid hormone or hematology comparisons. This significant difference was the comparison of the mean BUN value between the 1st and 3rd quartiles.

In a similar fashion for the 56 non-production Antwerp male employees, their clinical chemistry, thyroid hormone and hematology results are presented in Tables 7, 8 and 9, respectively, for their quartile distribution of serum PFOS. In this analysis, the highest quartile had a mean serum PFOS level of 0.90 ppm (range 0.49 - 1.76) compared to a mean of 0.13 ppm (range 0.05-0.20 ppm) in the lowest quartile. No significant mean differences were observed for demographic (Table 7), clinical chemistry (Table 7), thyroid hormone (Table 8) or hematology (Table 9) comparisons between the serum PFOS quartile distributions.

Among the 49 Antwerp production and non-production female employees analyzed as a group (Table 10), the highest quartile mean serum PFOS level was 0.26 ppm (range 0.15 - 0.55) compared to the lowest quartile mean serum PFOS level of 0.06 ppm (range 0.04 - 0.08 ppm). The highest serum PFOS quartile did not significantly differ demographically than the other three quartiles (Table 10). The lower three quartiles had some significant differences between themselves for the mean comparisons of years worked and drinks per day. Only one clinical chemistry, BUN, was significantly different between the quartiles as the 3rd and 4th quartiles had higher mean BUN values than the 1st quartile. All mean values were within reference ranges. No significant mean thyroid hormone (Table 11) or hematology (Table 12) difference was observed between the quartiles.

A total of 161 Decatur production male employees were stratified based on their quartile distribution of serum PFOS (Table 13). The highest quartile had a 3.22 ppm mean serum PFOS level (range 2.31 - 10.06) compared to 0.55 ppm mean serum PFOS level in the lowest quartile. There were no significant mean demographic differences

between the four quartiles and the only clinical chemistry test that was significantly different was ALT (Table 13). The highest quartile had a significantly higher mean ALT level (44 IU/ml) compared to the 1st (33 IU/ml), 2nd (32 IU/ml) or 3rd (33 IU/ml) quartiles. There were no significant mean differences for the Decatur male production employee quartile distributions for thyroid hormones (Table 14), hematology (Table 15) or urinalysis (Table 16) results.

Among the 54 Decatur non-production male employees (Table 17), their highest quartile mean serum PFOS level was 1.66 ppm (range 1.00 - 2.95 ppm) compared to the lowest quartile mean of 0.19 ppm (range 0.06 - 0.29 ppm). The highest quartile worked almost twice as long as the lowest quartile (Table 17). There were no significant differences in other demographics, clinical chemistries (Table 17), thyroid hormones (Table 18), hematology (Table 19) or urinalysis (Table 20) results among the quartile distributions.

Among the 48 Decatur production and non-production female employees (Table 21), the highest quartile had a mean serum PFOS level of 2.04 ppm (range 1.38 - 3.62 ppm) compared to the lowest quartile mean serum PFOS level of 0.20 ppm (range 0.06 - 0.31 ppm). There were no significant differences between the quartiles in relation to demographics (Table 21), clinical chemistries (Table 21) or thyroid hormones (Table 22). The third quartile had a significantly lower mean platelet count than the 1st quartile (Table 23); however, the fourth quartile was not significantly lower than the 1st quartile. Urinalysis findings did not differ by quartile (Table 24).

Presented in Table 25 are the number (and percentage) of Antwerp or Decatur employees which had above reference range values for hepatic clinical chemistry tests.

These findings in Table 25 are stratified by serum PFOS quartile distribution within each of the gender and production/non-production categories. Because each sub-population has a different serum PFOS quartile distribution, comparisons should only be done within each location-, production- and gender-specific category. Also presented is the number and percentage of employees who had one or more liver enzyme and bilirubin tests above the reference ranges (see aggregate total liver panel). The percentage of Antwerp employees whose liver enzyme tests were above reference range values was comparable for production and non-production male employees. Among Decatur employees, there was a higher percentage of production male employees in the 4th quartile for ALT, GGT and the total liver panel than the other quartiles. For non-production male employees, the highest percentages occurred in the second or third quartiles. Neither Antwerp or Decatur female employees had percentages consistent with any trend in the quartile distributions.

Provided in Tables 26 and 27 are the serum PFOS quartile distributions for the combined 421 Antwerp and Decatur production and non-production male employees. The highest quartile (4th) had a mean serum distribution of 2.69 ppm (range 1.69 – 10.06 ppm) compared to 0.27 ppm mean (range 0.04 – 0.42 ppm) compared to the lowest (1st) quartile distribution. It is important to note that the number (and percentages) of Antwerp versus Decatur employees in each of these four quartiles differ (see footnote to Table 26). In the lowest (1st) quartile, there is a greater percentage of Antwerp than Decatur male employees and more non-production than production employees. In the subsequent higher serum PFOS quartiles, the percentage of Decatur production male employees increased and the percentage of non-production male employees, whether

from Antwerp or Decatur, decreased. These differences were also reflected in the demographics between quartiles. For example, demographically the trend from the lowest to highest quartile increased with age, BMI and years worked and decreased with the mean number of alcohol drinks per day. Likewise, the means of the clinical chemistry and thyroid hormone tests were reflective of the higher percentage of Antwerp employees in the lower quartiles and higher percentage of Decatur employees in the higher quartiles. Mean triglyceride and alkaline phosphatase levels were lower and total bilirubin levels were higher in the lowest quartile compared to the highest quartile. For thyroid hormones, T3 was lower in the 1st quartile compared to the 4th quartile and THBR was significantly higher.

Combined analyses of Antwerp and Decatur production and non-production female employees (Tables 28 and 29) presented a similar distribution of employees by location and production pattern as was observed with the production and non-production male employees (Tables 26 and 27). Antwerp female employees predominated in the lowest quartile and Decatur female employees predominated in the highest quartile. This distribution difference is then seen with the lower mean age, BMI and alkaline phosphatase findings and the greater number of drinks per day and higher total bilirubin levels in the lowest quartile compared to the highest quartile. Also observed was a lower mean GGT and blood glucose level in the lowest quartile when compared to the highest quartile. There were no thyroid hormone differences between the quartile distributions (Table 29).

Summarized in Table 30 are the combined number of Antwerp and Decatur employees (and percentages) who had hepatic clinical chemistry tests above reference

range values stratified by quartile of the serum PFOS distribution. Among male employees, twelve percent of the employees had above reference range values for ALT and GGT in the 4th quartile compared to 4 to 8 percent in the 1st through 3rd quartiles. For the total liver panel, 23 percent of the male employees had one or more liver clinical chemistry tests above the reference range value compared to 14 to 16 percent in the lower three quartiles. No differences were observed within the female employee population. These percentages were not adjusted for potential confounding factors (e.g., BMI).

Because the higher liver enzyme function test results in the 4th quartile might be confounded by demographics (higher BMI, older age) and/or clinical chemistry tests (triglycerides) reflective of dietary differences, multivariable regression analyses were conducted on the combined Antwerp and Decatur male employee participants. Each regression model had the following variables: production job (yes = 1; no = 0); Antwerp/Decatur (1 = Antwerp; 0 = Decatur); age, BMI, cigarettes per day, drinks per day and years worked. For the analyses that involved hepatic clinical chemistry tests, triglycerides was also considered a potential explanatory variable. Regression models analyzed serum PFOS, serum PFOA, serum PFOS and PFOA, and total organic fluorine (TOF).

Provided in tables 31 through 34 are the analyses for these fluorochemical comparisons in relation to their effect on cholesterol, adjusted for the other explanatory variables. Serum PFOS was positively associated with cholesterol although its explanation of the variability of cholesterol in the model was less than 1 percent (see partial R^2). (Note: This positive association is opposite that of the well-established negative association between serum cholesterol and PFOS that have been shown to occur

in toxicological studies at threshold serum doses that were approximately 2 orders of magnitude higher than those serum PFOS levels observed in these employees.). Likewise, there was a positive association for PFOA and TOF but not the combined effects of PFOS and PFOA, with cholesterol. Again, this is contrary to the toxicological research that has shown PFOA lowers serum cholesterol. Age and drinks per day were significant variables in the model with cholesterol. PFOS or TOF were significantly associated with HDL, but PFOA was negatively associated (Tables 35 through 38). As to be expected, BMI and drinks per day were strongly associated with HDL. Analysis of triglycerides showed PFOS, PFOA and TOF were positively associated (Tables 39 through 42). PFOA appeared to be the more significant predictor than PFOS. (Note: PFOS and PFOA have decreased serum triglyceride levels at toxicological doses, not increased serum triglyceride levels.) Age, BMI and cigarettes smoked per day were significant variables in the triglyceride models found in Tables 39 through 42. Provided in Figures 1 through 3 are scatter plots of the simple linear regressions between the natural log of serum triglycerides and PFOA for Antwerp male, Decatur male and Antwerp and Decatur female employees.

Multivariable regression model results for the hepatic clinical chemistry analyses are found in Tables 43 through 62. Because of the potential confounding positive association with serum triglycerides, this variable is added to these models. No significant associations were observed with PFOS, PFOA and TOF in relation to alkaline phosphatase (Tables 43 through 46), GGT (Tables 47 through 50) or AST (Tables 51 through 54). Although PFOS or PFOA were not significantly associated with ALT

(Tables 55 – 57), TOF was positively associated with ALT (Table 58). PFOS, PFOA or TOF were not significant predictors of total bilirubin (Tables 59-62).

Multivariable regression analyses of the thyroid hormones resulted in no significant associations of PFOS, PFOA or TOF with TSH (Tables 63 – 66), T4 (Tables 67 – 70), Free T4 (Tables 71 – 74), THBR (Tables 75 – 78) or FTI (Tables 79 – 82). PFOS, PFOA and TOF were positively associated with T3 although contributed minimally to the variation explained in the model (see partial R^2).

DISCUSSION

Although voluntary participation rates ranged from 53 percent (Decatur) to 75 percent (Antwerp), the 2000 fluorochemical medical surveillance program had the most (in absolute numbers) employee male and female participants ever for both locations. This is likely due to a combination of factors including 1) greater knowledge of the collective (individual and research) value of the fluorochemical medical surveillance program; 2) employee awareness about the persistence and prevalence of PFOS in human tissue and the environment; and 3) the company's May 16, 2000 phase out announcement that it would cease production of perfluorooctanyl chemistry in certain repellents and surfactants by the end of 2000.

Serum PFOS and PFOA levels were comparable to those previously reported for employees at these manufacturing operations. Serum levels appeared to be log normally distributed with the highest values for PFOS at 10 ppm. This upper tail of the serum PFOS distribution was also reported in a random sample analysis of Decatur employees conducted in 1998 (Olsen et al 1999b). Separate reports examine the employees' serum

PFOS, PFOA, PFHS, PFOSAA, M570, PFOSA and M556 levels measured in the 2000 fluorochemical medical surveillance program with their workplace operations in Antwerp (Olsen et al, 2001b) and Decatur (Olsen et al, 2001c).

We continued to observe consistent differences between Antwerp and Decatur employees regarding their demographics and lifestyle differences. In particular, Antwerp male employees, on average, were younger (and thus worked less), had much lower BMIs and drank more alcoholic beverages than their Decatur counterparts. All three differences can be important confounding variables when analyzing lipid and hepatic clinical chemistry tests. We have also consistently seen higher total bilirubin values among Antwerp employees since 1995 which may be partially attributable to a greater prevalence of Gilbert's syndrome (Olsen et al 1998a; 1999a).

An inconsistent finding from these aggregate analyses was the positive associations in the multivariable models reported between PFOS and serum cholesterol and PFOA and serum cholesterol and triglycerides. There is a substantial body of toxicological literature to suggest these associations are spurious because PFOS (in rats and primates) has been reported to decrease serum cholesterol and triglyceride levels (3M Company 2000; Haughom and Spydevold 1992; Ikeda et al 1987; Pastoor et al 1987; Seacat et al 2001a; 2001b; Sohlenius et al 1993). On the other hand, there is inconsistent evidence for hypolipidemia with PFOA in rodents (Pastoor et al 1987; Haughom and Spydevold 1992) and no effect observed in primates (Butenhoff et al 2001). In primates, there was no association observed between PFOA and cholesterol or triglycerides (Butenhoff et al 2001). There is no toxicological evidence that at the serum PFOA levels observed in our medical surveillance program that PFOA would have resulted in

hyperlipidemic associations. In addition, the PFOA levels observed among Antwerp and Decatur employees in 2000 was lower than those measured in 3M's Cottage Grove manufacturing employees whose serum PFOA levels have been assayed as high as 100 ppm. Hypolipidemic or hyperlipidemic effects have not been associated with serum PFOA levels among these Cottage Grove employees (Gilliland and Mandel 1996; Olsen et al, 2000). Most recently, the 2000 Cottage Grove fluorochemical medical surveillance program analysis again showed no association between serum PFOA levels and serum cholesterol or triglycerides (as seen in Figure 4). (Note: The serum PFOA levels graphed in Figure 4 are substantially higher than those cited in Figures 1 through 3 for the Antwerp and Decatur male and female employees.) We therefore believe that it is highly unlikely that these are causal associations observed in the 2000 fluorochemical medical surveillance data between PFOA and serum cholesterol and triglycerides.

Previous toxicological and epidemiological research has also not suggested positive associations between elevated serum liver enzymes results and serum PFOS or PFOA that were at the levels observed in the Antwerp and Decatur employee population (3M Company, 2000; Butenhoff et al 2001; Gilliland and Mandel 1996; Olsen et al 1998a; 1999a; 2000; Seacat et al 2001a; 2001b). In this 2000 fluorochemical medical surveillance program we observed, among Decatur production employees, a significantly greater mean ALT among those workers in the highest serum PFOS quartile distribution compared to the other three quartiles. This highest quartile of Decatur employees also had the greatest percentage of employees with ALT (28%) and GGT (15%) values above the reference range as well as the total liver panel (35%). A comparable percentage (36%) was observed among Decatur non-production employees in the second lowest

quartile with one or more hepatic clinical chemistry tests above the reference range. When male employees were combined by production status and location (as seen in Table 30), we reported an upward trend in the percentage of employees in the highest quartile with values above the reference range for ALT (12%), GGT (12%) and total liver panel (23%). However, after adjusting the employees' individual liver function values by potential confounding factors including age, BMI, number of alcoholic drinks per day, cigarettes per day and serum triglyceride values, we found no association between liver function values and PFOS or PFOA. We therefore suspect that the univariate associations were influenced by known confounders of liver function analyses

A battery of thyroid hormone tests were included in the 2000 fluorochemical medical surveillance program due to preliminary, albeit biologically inconsistent, findings in toxicological studies that have yet to be completed. Our surveillance data do not suggest any biologically significant associations between thyroid hormones and employees' measured serum PFOS, PFOA or calculated TOF levels.

A retrospective cohort mortality study of Decatur employees from 1961-1997 reported 3 deaths from bladder cancer compared to 0.2 expected in the subgroup of workers with the highest potential exposure to perfluorooctanesulfonyl fluoride (POSF)-based chemistry and materials (Alexander 2001b). It was not determined whether this association was fluorochemical-related or possibly due to other non-fluorochemical occupational or non-occupational exposures. An analysis of episode of cares (Olsen et al 2001d) reported a higher reoccurrence of cystitis among female Decatur chemical plant workers than their counterparts in the film plant although the actual prevalence of unique individuals with episodes of care regarding cystitis was similar. No differences were

reported among male chemical and film plant employees. The analysis of these 2000 fluorochemical medical surveillance data showed no association between the prevalence of abnormal urinalyses and employee serum PFOS levels among the Decatur employees.

Limitations of this study design include its cross-sectional nature which does not adequately allow for the assessment of temporal changes. However, the large participation of employees in 2000 who may have participated in the 1994/95 and/or 1997 fluorochemical medical surveillance programs at these two manufacturing sites has enabled a longitudinal analysis to be performed. This longitudinal analysis is the focus of a separate 3M investigation (Olsen et al, 2001a). Although still very limited in numbers, we were able to provide separate cross-sectional analyses for female employees, for the first time, which showed no biologically relevant associations between serum PFOS and/or PFOA levels with clinical chemistries, thyroid hormones or hematology results. Because 3M has announced a phase-out of the production of perfluorooctanyl chemistry-related materials, we anticipate that the Antwerp and Decatur employee population mean PFOS and PFOA serum levels should be lower when measured during the next fluorochemical medical surveillance program. These future analyses may be hindered by the fewer employees in the workforce as a consequence of the phase-out announced by the company. Another study limitation was the lower serum PFOS and PFOA levels measured among these employees compared with those suspected to cause effects in laboratory animals.

In summary, the findings from the 2000 fluorochemical medical surveillance program continue to suggest that Antwerp and Decatur fluorochemical production and non-production employees do not show substantial changes in serum hepatic enzymes,

cholesterol, or lipoproteins associated with the serum PFOS and PFOA levels measured. A separate longitudinal analysis is reported for the fluorochemical medical surveillance Antwerp and Decatur program data from 1994 through 2000.

ACKNOWLDGEMENTS

The investigators acknowledge the contributions of Kimberly Young in the prepartion of this report.

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Table 1

Number of Employee Participants in the 2000 Antwerp and Decatur Medical Surveillance Programs

Antwerp (N = 255)				Decatur (N = 263)			
Male (N = 206)		Female (N = 49)		Male (N = 215)		Female (N = 48)	
Production	Non-Production	Production	Non-Production	Production	Non-Production	Production	Non-Production
150 (73)*	56 (27)*	6 (12)*	43 (88)*	161 (75)*	54 (25)*	30 (63)*	18 (37)*

*Percent in parenthesis

Table 2

Mean Value for Male Employee Participants' Serum Fluorochemical Levels, Demographics, Clinical Chemistries and Thyroid Results

	All		Production		Non-Production	
	Antwerp (N = 206)	Decatur (N = 215)	Antwerp (N = 150)	Decatur (N = 161)	Antwerp (N = 56)	Decatur (N = 54)
PFOS	0.96[d]	1.40	1.16[c]	1.63	0.42[b]	0.73
PFOA	1.03[d]	1.90	1.28[d]	2.34	0.34[b]	0.59
TOF	1.60[d]	2.65	1.97[d]	3.18	0.61[b]	1.07
Age	37[d]	43	36[d]	42	40[b]	45
BMI	24.8[d]	28.8	24.6[d]	28.9	25.2[d]	28.4
Years Worked	13[c]	16	12[a]	15	15[c]	22
Cigarettes/day	4	6	5	6	2	5
Drinks/day	1.1[d]	0.1	1.1[d]	0.1	1.1[d]	0.2
Cholesterol	218	215	215	217	225[a]	209
HDL	55[d]	44	55[d]	43	55[c]	45
Triglycerides	124[d]	191	124[d]	198	122[b]	169
Alk Phos	60[d]	74	60[d]	76	60[a]	67
GGT	23[d]	31	23[d]	31	26[b]	29
AST	23[c]	26	23[d]	26	24	25
ALT	23[d]	35	22[d]	36	25	31

Table 2 (continued)

Total Bilirubin	1.0[d]	0.7	1.0[d]	0.7	1.1[d]	0.8
Direct Bilirubin	0.1[c]	0.1	0.1[b]	0.1	0.1	0.1
BUN	19[d]	15	19[d]	15	19[d]	15
Creatinine	1.2	1.1	1.1[d]	1.2	1.2	1.1
Glucose	85[d]	95	84[d]	95	87[a]	94
TSH	2.0[a]	2.9	2.0[a]	3.1	1.9	2.2
T4	8.2	8.4	8.3	8.4	8.1	8.5
Free T4	1.1[c]	1.1	1.1[c]	1.1	1.1	1.1
T3	131[b]	125	132[a]	127	126	120
THBR	34[d]	31	34[d]	30	35[d]	31
FTI	2.7[d]	2.5	2.7[d]	2.5	2.7[a]	2.5

[a] $p < .05$ compared to Decatur (t test)
[b] $p < .01$ compared to Decatur (t test)
[c] $p < .001$ compared to Decatur (t test)
[d] $p < .0001$ compared to Decatur (t test)

Table 3

Mean Values for Female Employee Participants' Serum Fluorochemical Levels, Demographics, Clinical Chemistries and Thyroid Results

	Antwerp (N = 49)	Decatur (N = 48)
PFOS	0.13[d]	0.93
PFOA	0.07[d]	1.23
TOF	0.17[d]	1.76
Age	36	42
BMI	22.8[d]	27.7
Years Worked	12[a]	13
Cigarettes/day	2[d]	5
Drinks/day	0.5[d]	0.1
Cholesterol	208	200
HDL	68[a]	59
Triglycerides	94[d]	133
Alk Phos	46[a]	65
GGT	12[d]	18
AST	18	20
ALT	13[d]	19
Total Bilirubin	0.8[b]	0.6
Direct Bilirubin	0.1	0.1
BUN	16	12
Creatinine	0.9	0.8
Glucose	85	87
TSH	2.3	2.3
T4	10.2	9.3
Free T4	1.1[b]	1.0
T3	148[b]	128
THBR	30[a]	28
FTI	2.9[d]	2.5

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[a] $p < .05$ compared to Decatur (student t test)
[b] $p < .01$ compared to Decatur (student t test)
[c] $p < .001$ compared to Decatur (student t test)
[d] $p < .0001$ compared to Decatur (student t test)

Table 4

Antwerp Male Production Employee (N = 150)
Fluorochemical, Demographic and Clinical Chemistry Results by Quartile of Serum PFOS Distribution

	Quartile 1 (N = 37)				Quartile 2 (N = 38)				Quartile 3 (N = 38)				Quartile 4 (N = 37)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
PFOS	0.29[3,4]	0.33	0.11	0.04 – 0.41	0.58[3,4]	0.57	0.12	0.41 – 0.78	1.18[1,2,4]	1.16	0.22	0.79 – 1.66	2.61[1,2,3]	2.27	1.06	1.67 – 6.24
PFOA	0.94[4]	0.42	1.06	0.02 – 4.03	1.51	0.72	1.70	0.07 – 7.04	1.02	1.00	0.60	0.21 – 3.27	1.66[1]	1.64	0.81	0.25 – 3.59
TOF	0.92[2,3,4]	0.60	0.78	0.05 – 3.03	1.63[1,4]	1.08	1.26	0.42 – 5.69	1.82[1,4]	1.80	0.55	1.03 – 3.14	3.51[1,2,3]	3.30	1.18	1.92 – 7.36
Age	33[4]	34	7	23 – 48	37	36	9	21 – 56	37	36	9	22 – 55	39[1]	39	8	28 – 55
BMI	24.3	23.8	2.7	19.2 – 33.2	24.9	24.3	3.1	19.0 – 34.7	25.0	25.3	2.8	17.5 – 32.3	24.3	24.7	3.0	17.8 – 30.9
Years Worked	8[2,3,4]	5	6	2 – 25	12[1]	11	9	2 – 29	12[1]	13	7	1 – 29	15[1]	15	6	5 – 29
Cigarettes/day	5	0	7	0 – 20	5	0	8	0 – 25	4	0	6	0 – 20	7	0	8	0 – 25
Drinks/day	1.2	1.0	1	0 – 4	1.1	0.9	1.0	0 – 4	0.9	0.7	0.9	0 – 4	1.1	0.7	1.2	0 – 5
Cholesterol	207	202	39	145 – 308	216	217	41	148 – 295	212	196	41	105 – 297	226	232	46	122 – 316
HDL	57	57	13	32 – 85	52	49	10	38 – 72	54	53	12	29 – 80	57	51	19	26 – 119
Triglycerides	102	102	49	34 – 221	125	113	87	35 – 546	140	113	124	41 – 731	130	105	75	42 - 346
Alk Phos	60	61	15	34 – 96	60	60	15	30 – 113	59	59	15	30 – 94	61	62	14	21 – 89
GGT	20	16	11	8 – 53	24	20	16	8 – 89	21	19	11	10 – 64	26	19	19	7 – 85
AST	24	24	8	13 – 58	24	23	5	16 – 41	22	21	5	13 – 33	23	22	6	15 – 39
ALT	23	22	10	11 – 71	22	21	8	10 – 43	22	20	9	9 – 46	20	20	9	8 – 45
Total Bilirubin	1.0	1.0	0.3	0.6 – 1.6	1.0	0.9	0.4	0.5 – 2.0	1.0	1.0	0.3	0.5 – 2.3	1.0	0.9	0.3	0.4 – 2.2
Direct Bilirubin	0.1	0.1	0.04	0.0 – 0.2	0.1	0.1	0.1	0.0 – 0.3	0.1	0.1	0.03	0.0 – 0.2	0.1	0.1	0.1	0.0 – 0.4
BUN	18[3]	17	4	11 – 25	18	18	4	12 - 25	20[1]	19	5	14 – 31	19	19	4	11 – 30
Creatinine	1.1	1.1	0.2	0.9 – 1.5	1.1	1.1	0.2	0.8 – 1.7	1.1	1.1	0.2	0.8 – 2.0	1.1	1.0	0.2	0.8 – 1.5
Glucose	85	87	19	31 – 131	86	88	16	49 – 113	84	85	21	45 – 168	80	83	20	40 - 120

[1] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 1st quartile
[2] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 2nd quartile
[3] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 3rd quartile
[4] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 4th quartile

Table 5

Antwerp Male Production Employee (N = 150)
Thyroid Results* by Quartile of Serum PFOS Distribution**

	Quartile 1 (N = 37)				Quartile 2 (N = 38)				Quartile 3 (N = 38)				Quartile 4 (N = 37)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
TSH	1.8	1.6	1.1	05 – 5.7	2.0	2.0	0.9	0.7 – 5.5	2.0	1.7	1.1	0.8 – 6.1	2.2	1.6	3.0	0.5 – 19.4
T4	8.2	8.3	1.5	5.4 – 11.5	8.5	8.6	1.4	6.6 – 12.0	8.2	8.1	1.4	5.0 – 11.5	8.1	8.2	1.4	4.7 – 11.0
Free T4	1.2	1.1	0.2	0.9 – 1.5	1.1	1.1	0.1	0.9 – 1.4	1.1	1.1	0.2	0.6 – 1.6	1.1	1.1	0.2	0.8 – 1.6
T3	127	127	15	95 – 155	134	132	17	102 – 169	132	132	19	97 – 180	136	137	22	98 – 185
THBR	34	34	3	28 – 40	34	34	2	29 – 39	34	34	3	29 – 43	34	34	2	29 – 41
FTI	2.8	2.6	0.5	2.1 – 4.2	2.8	2.8	0.4	2.1 – 4.0	2.7	2.7	0.4	1.9 – 3.9	2.7	2.7	0.4	1.6 – 3.6

*No significantly different (P < .05, Bonferroni (Dunn) t test) mean values
**See Table 4 for serum PFOS quartile distribution

Table 6

Antwerp Male Production Employee (N = 150)
Hematology Results* by Quartile of Serum PFOS Distribution**

	Quartile 1 (N = 37)				Quartile 2 (N = 38)				Quartile 3 (N = 37)				Quartile 4 (N = 37)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
HCT	46	46	3	41 – 53	46	46	3	39 – 51	46	46	3	40 – 51	46	46	3	41 – 51
HGB	15.5	15.4	0.8	14.0 – 17.4	15.5	15.5	0.9	13.2 – 18.1	15.4	15.5	0.8	13.6 – 17.3	15.3	15.3	0.9	13.4 – 17.1
RBC	5.2	5.2	0.3	4.6 – 5.9	5.1	5.2	0.3	4.4 – 5.9	5.1	5.1	0.3	4.7 – 5.9	5.0	5.0	0.3	4.0 – 5.8
WBC	7.0	6.4	1.8	4.2 – 11.4	7.3	7.1	1.8	4.4 – 11.5	7.6	7.4	1.6	5.2 – 11.1	7.2	6.9	2.1	4.5 – 15.6
Platelets	244	242	57	138 – 380	254	250	51	167 – 373	253	242	73	106 – 427	249	247	55	137 - 369

*No significantly different (P < .05, Bonferroni (Dunn) t test) mean values
**See Table 4 for serum PFOS quartile distribution

Table 7

Antwerp Male Non-Production Employee (N = 56)
Fluorochemical, Demographic and Clinical Chemistry Results by Quartile of Serum PFOS Distribution

	Quartile 1 (N = 14)				Quartile 2 (N = 13)				Quartile 3 (N = 15)				Quartile 4 (N = 14)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
PFOS	0.13[3,4]	0.13	0.05	0.05 – 0.20	0.27[4]	0.28	0.03	0.21 – 0.31	0.40[1,4]	0.41	0.05	0.32 – 0.48	0.90[1,2,3]	0.64	0.47	0.49 – 1.76
PFOA	0.18[4]	0.06	0.46	0.01 – 1.78	0.19[4]	0.15	0.13	0.05 – 0.51	0.37	0.32	0.23	0.06 – 0.85	0.62[1,2]	0.42	0.49	0.12 – 1.78
TOF	0.24[3,4]	0.17	0.34	0.06 – 1.38	0.37[4]	0.35	0.11	0.22 – 0.64	0.60[4]	0.54	0.19	0.37 – 0.96	1.22[1,2,3]	1.09	0.69	0.56 – 3.01
Age	40	36	13	23 – 58	41	42	6	31 – 53	38	40	9	25 – 56	40	41	9	26 – 55
BMI	24.6	25.1	3.3	19.9 – 31.3	25.4	24.3	3.3	21.7 – 34.2	26.1	25.1	3.5	21.1 – 33.9	24.4	24.2	3.0	20.4 – 30.1
Years Worked	15	15	10	1 – 29	17	16	6	6 – 29	13	13	8	3 – 26	15	15	9	2 – 27
Cigarettes/day	1	0	5	0 - 20	0	0	0	0 – 0	4	0	7	0 – 20	2	0	4	0 – 10
Drinks/day	1.1	0.7	0.9	0.1 – 2.9	1.0	0.7	1.3	0.0 – 5.0	1.1	1.1	0.9	0.1 – 3.4	1.3	0.9	1.6	0.0 – 6.4
Cholesterol	215	218	37	140 – 293	244	231	43	191 – 331	219	223	39	157 – 277	225	231	33	178 – 277
HDL	55	54	11	40 – 78	61	58	27	31 – 121	53	49	10	40 – 77	54	57	18	31 – 100
Triglycerides	94	78	39	45 – 177	159	118	129	36 – 463	120	99	61	49 – 254	117	95	72	37 - 262
Alk Phos	59	59	17	30 – 91	62	63	11	43 – 80	61	61	18	30 – 94	57	56	12	39 – 77
GGT	20	18	14	8 – 65	32	21	26	13 – 111	26	16	21	7 – 80	25	16	26	6 – 107
AST	24	22	7	15 – 37	25	23	8	15 – 44	25	22	7	14 – 38	24	23	8	16 – 49
ALT	24	21	10	12 – 41	27	25	14	10 – 61	24	21	11	11 – 46	24	21	11	12 – 44
Total Bilirubin	1.2	1.2	0.3	0.5 – 1.9	1.2	1.2	0.4	0.8 – 2.0	0.9	0.9	0.3	0.5 – 1.7	1.1	1.0	0.3	0.7 – 1.9
Direct Bilirubin	0.1	0.1	0.04	0.1 – 0.2	0.1	0.1	0.04	0.1 – 0.2	0.1	0.1	0.1	0.0 – 0.3	0.1	0.1	0.03	0.1 – 0.2
BUN	18	18	4	15 – 27	22	19	15	14 – 71	18	18	4	13 – 25	19	19	3	14 – 24
Creatinine	1.2	1.2	0.2	1.0 – 1.7	1.5	1.1	1.3	0.9 – 5.8	1.2	1.2	0.2	0.8 – 1.5	1.1	1.1	0.2	0.8 – 1.6
Glucose	84	86	14	60 – 104	88	92	15	50 – 107	87	95	20	48 – 114	91	90	14	68 - 115

[1] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 1st quartile
[2] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 2nd quartile
[3] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 3rd quartile
[4] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 4th quartile

Table 8

Antwerp Male Non-Production Employees (N = 56)
Thyroid Results* by Quartile of Serum PFOS Distribution**

	Quartile 1 (N = 14)				Quartile 2 (N = 13)				Quartile 3 (N = 15)				Quartile 4 (N = 14)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
TSH	2.1	2.0	1.1	0.4 – 4.2	2.0	1.9	1.2	0.7 – 5.4	1.6	1.7	1.0	0.03 – 4.3	2.0	1.6	1.4	1.0 – 6.1
T4	8.9	8.9	1.1	6.8 – 10.4	7.8	8.6	1.5	5.0 – 9.4	7.9	7.7	1.3	5.7 – 9.8	7.9	7.7	1.9	4.2 – 11.4
Free T4	1.2	1.2	0.2	1.0 – 1.5	1.1	1.2	0.2	0.9 – 1.5	1.1	1.1	0.2	0.9 – 1.5	1.1	1.2	0.2	0.9 – 1.4
T3	131	128	16	106 – 164	120	118	12	103 – 145	128	126	25	91 – 161	125	129	18	87 – 147
THBR	33	34	2	30 - 36	35	33	4	30 – 42	35	34	3	28 – 41	35	34	2	32 – 41
FTI	2.9	3.0	0.3	2.3 – 3.4	2.6	2.7	0.4	2.0 – 3.4	2.7	2.7	0.4	2.1 – 3.5	2.7	2.7	0.6	1.7 – 3.7

*No significantly different (P < .05, Bonferroni (Dunn) t test) mean values
**See Table 7 for serum PFOS quartile distribution

Table 9

Antwerp Male Production Employee (N = 49)
Hematology Results* by Quartile of Serum PFOS Distribution**

	Quartile 1 (N = 14)				Quartile 2 (N =13)				Quartile 3 (N = 15)				Quartile 4 (N = 14)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
HCT	44	44	2	40 – 48	47	47	2	42 – 49	46	46	3	42 – 51	45	45	2	41 – 50
HGB	15.1	15.0	1.1	12.2 – 17.0	15.6	15.5	0.7	14.3 – 16.5	15.4	15.3	0.8	14.0 – 17.0	15.3	15.3	0.8	14.1 – 17.1
RBC	5.1	5.1	0.2	4.8 – 5.6	5.1	5.1	0.3	4.6 – 5.6	5.1	5.1	0.3	4.5 – 5.7	5.0	5.0	0.3	4.7 – 5.5
WBC	6.6	6.4	1.3	5.1 – 10.1	6.9	6.5	1.7	4.7 – 10.7	6.5	6.0	2.1	3.8 – 11.0	6.5	6.4	1.3	4.9 – 9.6
Platelets	228	226	23	183 – 258	267	270	49	206 – 353	225	221	53	129 – 335	234	234	39	172 - 306

*No significantly different (P < .05, Bonferroni (Dunn) t test) mean values
**See Table 7 for serum PFOS quartile distribution

Table 10

Antwerp Female Production* and Non-Production Employee (N = 49)
Fluorochemical, Demographic and Clinical Chemistry Results by Quartile of Serum PFOS

	Quartile 1 (N = 12)				Quartile 2 (N = 12)				Quartile 3 (N = 13)				Quartile 4 (N = 12)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
PFOS	0.06	0.06	0.01	0.04 – 0.08	0.09	0.09	0.01	0.08 – 0.10	0.11	0.11	0.01	0.10 – 0.14	0.26[1,2,3]	0.21	0.13	0.15 – 0.55
PFOA	0.03	0.02	0.02	0.01 – 0.08	0.03	0.02	0.01	0.01 – 0.06	0.04	0.03	0.01	0.02 – 0.07	0.20[2]	0.09	0.31	0.02 – 1.11
TOF	0.08	0.07	0.02	0.05 – 0.12	0.09	0.09	0.01	0.07 – 0.11	0.12	0.11	0.02	0.09 – 0.15	0.40[1,2,3]	0.26	0.34	0.13 – 1.25
Age	32	31	8	24 – 50	36	34	9	24 – 52	38	36	5	31 – 48	37	36	6	29 – 52
BMI	23.8	23.5	2.6	18.8 – 28.3	21.9	21.8	2.5	18.4 – 26.3	23.7	21.3	4.6	17.3 – 32.3	21.8	22.0	1.7	18.3 – 25.0
Years Worked	7[3]	5	7	0.8 – 22	13	12	8	4 – 29	15[1]	14	6	9 – 28	13	13	7	5 - 29
Cigarettes/day	1	0	3	0 – 10	2	0	6	0 – 20	2	0	5	0 – 15	2	0	4	0 – 13
Drinks/day	0.2[3]	0.1	0.3	0 – 1.0	0.6	0.5	0.4	0.1 – 1.3	0.6[1]	0.4	0.4	0.0 – 1.4	0.6	0.5	0.5	0.1 – 1.6
Cholesterol	205	195	30	155 – 253	214	224	45	132 – 274	208	197	39	160 – 302	207	197	32	164 – 271
HDL	62	60	11	46 – 85	71	72	19	46 – 121	68	64	18	43 – 104	72	67	16	53 – 104
Triglycerides	111	99	57	46 – 248	73	80	27	26 – 112	98	93	43	46 – 172	94	87	44	32 - 171
Alk Phos	53	54	14	22 – 70	44	48	14	25 – 61	44	45	10	26 – 61	42	42	11	20 – 59
AST	21	20	5	14 – 31	17	17	5	11 – 27	18	17	6	9 – 26	17	15	6	12 – 33
ALT	14	12	7	8 – 35	12	12	2	8 – 17	15	13	7	6 – 34	11	11	3	7 – 18
GGT	12	10	8	3 – 32	11	11	5	2 – 19	14	10	10	7 – 41	10	10	4	5 – 23
Total Bilirubin	0.8	0.7	0.2	0.5 – 1.2	1.0	1.0	0.3	0.5 – 1.7	0.8	0.8	0.3	0.3 – 1.3	0.7	0.7	0.2	0.3 – 1.2
Direct Bilirubin	0.1	0.1	0.07	0.0 – 0.2	0.1	0.1	0.09	0.1 – 0.4	0.1	0.1	0.06	0.0 – 0.2	0.1	0.1	0.0	0.1 – 0.1
BUN	12[3,4]	12	2	9 – 16	15	15	3	11 – 23	18[1]	19	4	9 – 22	16[1]	16	3	13 – 23
Creatinine	0.9	0.9	0.2	0.6 – 1.1	0.9	0.9	0.2	0.7 – 1.3	1.0	1.0	0.2	0.7 – 1.4	1.0	1.0	0.1	0.8 – 1.2
Glucose	75	76	16	38 – 98	86	90	12	65 – 101	89	91	11	65 – 105	88	90	17	49 – 117

*Number of Female employees by production category by quartile

	Q1	Q2	Q3	Q4
Production	3	1	0	2
Non-Production	9	11	13	10

[1] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 1st quartile
[2] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 2nd quartile
[3] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 3rd quartile
[4] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 4th quartile

Table 11

Antwerp Female Production and Non-Production Employee (N = 49)
Thyroid Results* by Quartile of Serum PFOS Distribution**

	Quartile 1 (N = 12)				Quartile 2 (N = 12)				Quartile 3 (N = 13)				Quartile 4 (N = 12)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
TSH	2.0	1.9	1.4	0.03 – 4.9	2.4	2.4	1.0	0.6 – 4.1	2.2	1.8	1.8	0.03 – 6.7	2.6	2.0	1.6	1.0 – 6.5
T4	10.7	11.3	2.2	6.6 – 13.8	9.7	9.7	1.8	6.9 – 12.3	10.5	10.7	3.6	4.6 – 18.3	10.0	9.8	2.3	6.7 – 13.3
Free T4	1.1	1.1	0.1	0.8 – 1.3	1.1	1.2	0.1	0.9 – 1.3	1.4	1.1	1.0	0.7 – 4.6	1.0	1.0	0.1	0.9 – 1.2
T3	157	164	29	106 – 191	128	134	22	98 – 163	159	145	66	81 – 345	144	135	34	109 – 228
THBR	27	27	5	19 – 34	31	31	4	25 – 36	31	32	7	22 – 46	29	29	4	24 – 35
FTI	2.8	2.9	0.5	2.1 – 3.6	2.9	3.0	0.4	2.3 – 3.6	3.2	2.9	1.6	1.8 – 8.4	2.8	2.7	0.4	2.2 – 3.4

*No significantly different (P < .05, Bonferroni (Dunn) t test) mean values
**See Table 10 for serum PFOS quartile distribution

Table 12

Antwerp Female Production and Non-Production Employee (N = 49)
Hematology Results* by Quartile of Serum PFOS Distribution**

	Quartile 1 (N = 12)				Quartile 2 (N = 12)				Quartile 3 (N = 13)				Quartile 4 (N = 12)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
HCT	40	42	4	29 – 43	41	41	3	37 – 45	40	41	2	35 – 44	41	41	2	38 – 46
HGB	13.3	13.6	1.5	9.4 – 14.9	13.5	13.5	0.7	12.5 – 15.0	13.3	13.3	0.8	11.7 – 14.8	13.5	13.6	0.8	12.5 – 15.2
RBC	4.6	4.7	0.4	3.7 – 5.1	4.5	4.5	0.3	4.1 – 5.1	4.5	4.5	0.2	4.2 – 5.0	4.5	4.5	0.3	4.2 – 5.1
WBC	7.7	7.4	1.9	4.8 – 10.1	6.3	6.0	1.7	3.9 – 9.3	7.3	7.2	1.4	5.4 – 9.5	6.5	6.3	1.3	4.4 – 9.4
Platelets	261	246	50	189 – 379	275	282	49	211 – 374	277	251	68	202 – 426	269	260	64	181 - 406

*No significantly different (P < .05, Bonferroni (Dunn) t test) mean values
**See Table 10 for serum PFOS quartile distribution

Table 13

Decatur Male Production Employee (N = 161)
Fluorochemical, Demographic and Clinical Chemistry Results by Quartile of Serum PFOS Distribution

	Quartile 1 (N = 40)				Quartile 2 (N = 40)				Quartile 3 (N = 41)				Quartile 4 (N = 40)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
PFOS	0.55[2,3,4]	0.55	0.16	0.11 – 0.75	1.01[1,3,4]	0.99	0.18	0.76 – 1.30	1.74[1,2,4]	1.74	0.28	1.32 – 2.29	3.22[1,2,3]	3.03	1.22	2.31 – 10.06
PFOA	1.24[3,4]	1.24	0.67	0.06 – 2.72	1.82[4]	1.53	1.05	0.35 – 4.61	2.42[1,4]	2.37	1.16	0.76 – 7.48	3.88[1,2,3]	3.68	1.86	1.52 – 12.70
TOF	1.34[2,3,4]	1.34	0.52	0.14 – 2.52	2.20[1,3,4]	2.04	0.79	0.89 – 4.22	3.43[1,2,4]	3.32	1.06	1.75 – 6.61	5.75[1,2,3]	5.31	1.77	3.00 – 12.23
Age	43	44	9	26 – 63	42	41	9	26 – 61	42	43	8	28 – 57	41	41	10	27 – 60
BMI	29.0	28.1	3.7	24.5 – 37.6	28.4	27.3	5.2	17.2 – 50.1	29.9	29.2	5.0	22.6 – 45.5	28.3	28.3	4.0	19.9 – 39.2
Years Worked	12	4	13	2 – 38	13	5	12	2 – 34	17	22	12	2 – 38	16	14	11	3 – 38
Cigarettes/day	8	0	13	0 – 40	5	0	10	0 – 30	9	0	13	0 – 40	4	0	9	0 – 30
Drinks/day	0.2	0	0.3	0 – 1	0.1	0	0.2	0 – 1	0.1	0	0.2	0 – 1	0.1	0	0.2	0.0 – 1.0
Cholesterol	214	220	43	121 – 296	224	219	42	155 – 308	213	208	44	147 – 384	216	210	39	160 – 319
HDL	42	41	8	29 – 59	45	44	8	33 – 75	43	42	11	29 – 70	43	43	8	28 – 64
Triglycerides	232	198	139	32 – 633	165	137	101	32 – 550	202	167	138	44 – 792	195	175	128	39 – 796
Alk Phos	76	73	20	44 – 142	74	69	22	39 – 160	78	75	22	39 – 139	75	71	20	44 – 126
GGT	33	28	22	7 – 144	29	23	17	10 – 87	29	27	13	11 - 80	34	30	16	10 – 71
AST	26	25	7	16 – 42	26	25	7	15 – 51	25	24	7	7 – 39	29	26	11	15 – 69
ALT	33[4]	31	12	12 – 63	32[4]	28	17	6 – 103	33[4]	31	12	10 – 58	44[1,2,3]	37	23	12 – 99
Total Bilirubin	0.7	0.7	0.2	0.3 – 1.5	0.8	0.8	0.2	0.4 – 1.2	0.7	0.7	0.2	0.4 – 1.1	0.7	0.7	0.2	0.4 – 1.3
Direct Bilirubin	0.1	0.1	0.1	0.0 – 0.2	0.1	0.1	0.1	0.0 – 0.7	0.1	0.1	.05	0.0 – 0.2	0.1	0.1	0.1	0.0 – 0.6
BUN	15	15	5	9 – 33	15	15	4	8 – 30	15	14	3	8 – 23	15	15	5	6 – 26
Creatinine	1.1	1.1	0.2	0.7 – 1.6	1.1	1.1	0.2	0.8 – 1.7	1.4	1.0	2.2	0.8 – 15.0	1.0	1.1	0.2	0.8 – 1.4
Glucose	97	91	19	75 – 184	93	93	10	75 – 113	99	93	39	74 – 381	92	90	12	72 - 129

[1] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 1st quartile
[2] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 2nd quartile
[3] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 3rd quartile
[4] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 4th quartile

Table 14

Decatur Male Production Employee (N = 161)
Thyroid Results* by Quartile of Serum PFOS Distribution**

	Quartile 1 (N = 40)				Quartile 2 (N = 40)				Quartile 3 (N = 41)				Quartile 4 (N = 40)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
TSH	4.5	2.4	10.4	0.5 – 65.3	2.4	1.8	2.9	0.2 – 18.8	2.4	2.1	1.5	0.8 – 8.6	3.0	2.4	3.4	0.8 – 21.5
T4	7.9	8.2	1.3	4.6 – 10.7	8.5	8.5	1.5	3.3 – 11.4	8.5	8.2	1.7	4.7 – 12.9	8.5	8.4	1.2	5.1 – 11.4
Free T4	1.0	1.0	0.1	0.6 – 1.3	1.1	1.1	0.2	0.4 – 1.4	1.1	1.1	0.2	0.7 – 1.5	1.1	1.0	0.1	0.8 – 1.3
T3	122	118	19	96 – 186	124	122	19	93 – 196	127	119	24	87 – 172	135	136	23	97 – 190
THBR	31	31	3	24 – 38	30	30	2	26 – 37	31	31	3	26 – 37	30	30	3	25 – 38
FTI	2.4	2.4	0.3	1.2 – 3.0	2.5	2.5	0.5	1.0 – 3.4	2.6	2.5	0.5	1.5 – 4.1	2.5	2.4	0.4	1.9 – 3.4

*No significantly different (P < .05, Bonferroni (Dunn) t test) mean values
**See Table 13 for serum PFOS quartile distribution

Table 15

Decatur Male Production Employee (N = 161)
Hematology Results* by Quartile of Serum PFOS Distribution**

	Quartile 1 (N = 40)				Quartile 2 (N = 40)				Quartile 3 (N = 41)				Quartile 4 (N = 40)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
HCT	45	45	2.7	39-51	45	45	2.2	40-50	45	45	2.9	38-52	45	45	2.4	39-50
HGB	15.2	15.3	0.9	13.3 – 17.2	15.1	15.2	0.8	13.4 – 17.3	15.2	15.1	1.0	12.1 – 17.5	15.2	15.1	0.8	12.9 – 16.6
RBC	4.9	5.0	0.3	4.0 – 5.5	5.0	5.0	0.3	4.1 – 5.6	5.2	5.0	1.8	4.1 – 16.0	5.0	5.0	0.4	3.8 – 5.9
WBC	6.1	6.0	1.3	4.3 – 10.2	6.2	5.9	1.6	3.3 – 10.2	6.4	5.9	1.8	4.1 – 11.6	6.5	6.3	1.8	3.8 – 13.5
Platelets	206	200	45	126 – 332	224	222	42	146 – 353	223	220	47	122 – 328	216	213	46	132 - 307

*No significantly different (P < .05, Bonferroni (Dunn) t test) mean values
**See Table 13 for serum PFOS quartile distribution

Table 16

Decatur Male Production Employee (N = 161)
Urinalysis Results by Quartile of Serum PFOS Distribution*

	Quartile 1 N (%)	Quartile 2 N (%)	Quartile 3 N (%)	Quartile 4 N (%)
Albumin	1 (3)	2 (6)	1 (3)	1 (3)
Blood	3 (8)	4 (10)	4 (10)	1 (3)
Sugar	3 (8)	1 (3)	2 (1.2)	0 (0)

Number of Employees: Q1 = 40; Q2 = 40; Q3 = 41; Q4 = 40
*See Table 13 for serum PFOS quartile distribution

Table 17

Decatur Male Non-Production Employee (N = 54)
Clinical Chemistry Results by Quartile of Serum PFOS Distribution

	Quartile 1 (N = 13)				Quartile 2 (N = 14)				Quartile 3 (N = 14)				Quartile 4 (N = 13)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
PFOS	0.19[3,4]	0.20	0.08	0.06 – 0.29	0.39[4]	0.39	0.06	0.32 – 0.49	0.71[1,2,4]	0.70	0.16	0.50 – 0.98	1.66[1,2,3]	1.19	0.73	1.00 – 2.95
PFOA	0.34[4]	0.21	0.54	0.04 - 2.10	0.34[4]	0.30	0.15	0.16 – 0.61	0.54[4]	0.48	0.28	0.19 – 1.25	1.17[1,2,3]	1.07	0.60	0.35 – 2.05
TOF	0.42[3,4]	0.37	0.46	0.08 – 1.90	0.64[4]	0.60	0.21	0.40 – 1.12	0.98[1,4]	0.96	0.24	0.64 – 1.39	2.29[1,2,3]	1.88	0.91	1.13 – 3.74
Age	42	44	10	27 – 59	42	36	13	28 – 60	48	51	8	30 – 56	49	51	6	35 – 56
BMI	29.5	27.4	6.0	22.7 – 40.8	26.3	25.5	4.0	21.7 – 35.4	29.1	28.7	3.4	25.5 – 37.3	28.7	29.4	2.3	24 - 32
Years Worked	15.1	18.7	11.9	0.8 – 37.9	19.6	17.3	13.8	2.2 – 38.5	24.3	28.6	11.6	2.3 – 34.2	27.8[1]	31.8	8.6	4.5 – 35.4
Cigarettes/day	5	0	13	0 – 40	5	0	11	0 – 40	2	0	8	0 – 30	8	0	15	0 – 40
Drinks/day	0.2	0	0.3	0 – 0.8	0.3	0	0.7	0 – 2.0	0.2	0	0.5	0 – 1.6	0.1	0	0.2	0 – 0.8
Cholesterol	207	199	45	158 – 305	204	192	42	153 – 278	203	197	48	144 – 281	222	233	42	159 – 297
HDL	46	40	14	32 – 82	49	46	14	35 – 80	43	40	8	34 – 59	43	42	12	24 – 73
Triglycerides	157	185	63	38 – 254	129	96	64	59 – 241	161	154	65	62 – 284	232	122	173	69 - 512
Alk Phos	59	61	15	26 – 79	62	62	17	39 – 98	72	72	15	48 – 105	75	73	15	52 – 104
GGT	22	21	8	11 – 35	36	25	29	13 – 119	29	29	8	15 – 41	29	23	22	9 – 89
AST	25	22	7	16 – 42	28	27	10	16 – 48	27	25	6	16 – 39	22	23	5	14 – 29
ALT	28	23	16	15 – 74	33	32	20	14 – 91	35	33	12	24 – 66	28	27	6	20 – 41
Total Bilirubin	0.8	0.8	0.2	0.5 – 1.0	0.8	0.8	0.2	0.5 – 1.0	0.8	0.7	0.3	0.4 – 1.4	0.8	0.8	0.2	0.4 – 1.1
Direct Bilirubin	0.1	0.1	0.07	0.0 – 0.2	0.1	0.1	0.03	0.1 – 0.2	0.1	0.1	0.06	0.0 – 0.2	0.1	0.1	0.07	0.1 – 0.3
BUN	14	13	3	8 – 22	14	14	3	10 – 18	15	15	5	8 – 24	16	14	4	12 – 22
Creatinine	1.0	1.0	0.1	0.9 – 1.2	1.0	1.1	0.1	0.8 – 1.1	1.1	1.1	0.2	0.7 – 1.4	1.1	1.1	0.1	1.0 – 1.3
Glucose	88	89	8	76 – 99	89	89	6	79 – 100	94	92	10	70 – 112	103	91	26	83 - 166

[1] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 1st quartile
[2] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 2nd quartile
[3] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 3rd quartile
[4] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 4th quartile

Table 18

Decatur Male Non-Production Employee (N = 54)
Thyroid Results by Quartile of Serum PFOS Distribution**

	Quartile 1 (N = 13)				Quartile 2 (N = 14)				Quartile 3 (N = 14)				Quartile 4 (N = 13)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
TSH	2.1	1.8	1.0	0.8 – 4.2	2.1	1.9	1.3	0.03 – 5.2	3.0	2.0	2.7	1.6 – 11.8	1.6	1.5	0.9	0.4 – 3.6
T4	9.1	9.1	1.2	6.9 – 10.9	8.2	7.9	1.6	6.2 – 10.7	8.0	8.2	1.3	6.3 – 10.2	8.7	8.7	1.2	7.0 – 10.9
Free T4	1.1	1.1	0.1	0.1 – 1.3	1.1	1.1	0.1	0.9 – 1.3	1.0	1.1	0.1	0.8 – 1.2	1.2	1.2	0.1	0.9 – 1.4
T3	124	129	17	99 – 150	120	112	23	94 – 180	117	114	23	86 – 164	118	121	13	91 – 136
THBR	30	30	2	29 – 34	31	31	3	25 – 35	31	31	3	26 – 35	30	31	3	25 – 36
FTI	2.7	2.8	0.4	2.0 – 3.4	2.4	2.6	0.4	1.8 – 3.2	2.4	2.5	0.5	1.7 – 3.1	2.6	2.5	0.4	2.0 – 3.2

*No significantly different (P < .05, Bonferroni (Dunn) t test) mean values
**See Table 17 for serum PFOS quartile distribution

Table 19

Decatur Male Non-Production Employee (N = 54)
Hematology Results* by Quartile of Serum PFOS Distribution**

	Quartile 1 (N = 13)				Quartile 2 (N = 14)				Quartile 3 (N = 14)				Quartile 4 (N = 13)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
HCT	45	45	3	38 – 51	45	45	3	41 – 53	44	45	3	41 – 49	45	45	1	43 – 49
HGB	15.2	15.4	1.2	12.0 – 16.9	15.4	15.0	1.1	14.2 – 17.8	14.9	15.0	0.8	13.6 – 16.7	15.0	15.1	0.5	14.0 – 16.0
RBC	5.0	5.0	0.3	4.7 – 5.5	5.6	4.9	2.8	4.5 – 15.1	4.8	4.8	0.3	4.3 – 5.3	5.1	5.1	0.3	4.6 – 5.5
WBC	6.1	5.7	2.2	4.1 – 13.1	6.0	6.1	1.6	3.0 – 8.2	6.0	5.7	1.1	4.4 – 8.6	6.4	6.0	1.6	4.4 – 9.8
Platelets	245	223	62	134 – 337	219	217	30	172 – 266	230	206	58	149 – 361	212	203	34	167 - 258

*No significantly different (P < .05, Bonferroni (Dunn) t test) mean values
**See Table 17 for serum PFOS quartile distribution

Table 20

Decatur Male Non-Production Employee (N = 54)
Urinalysis Results by Quartile of Serum PFOS Distribution*

	Quartile 1 N (%)	Quartile 2 N (%)	Quartile 3 N (%)	Quartile 4 N (%)
Albumin	0 (0)	0 (0)	0 (0)	1 (8)
Blood	2 (15)	0 (0)	2 (15)	0 (0)
Sugar	0 (0)	0 (0)	0 (0)	0 (0)

Number of Employees: Q1 = 13; Q2 = 14; Q3 = 14; Q4 = 13
*See Table 17 for serum PFOS quartile distribution

Table 21

Decatur Female Production and Non-Production Employee (N = 48)
Clinical Chemistry Results by Quartile of Serum PFOS Distribution

	Quartile 1 (N = 12)				Quartile 2 (N = 12)				Quartile 3 (N = 12)				Quartile 4 (N = 12)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
PFOS	0.20[3,4]	0.20	0.08	0.06 – 0.31	0.49[3,4]	0.50	0.13	0.32 – 0.70	0.99[1,2,4]	0.92	0.16	0.77 – 1.30	2.04[1,2,3]	1.80	0.78	1.38 – 3.62
PFOA	0.40[3,4]	0.28	0.47	0.08 – 1.81	0.78[3,4]	0.60	0.92	0.10 – 3.50	1.77[1,2]	1.28	1.17	0.25 – 4.00	1.98[1,2]	1.54	1.27	0.85 – 5.41
TOF	0.48[3,4]	0.34	0.38	0.21 – 1.60	1.02[4]	0.94	0.72	0.33 – 3.02	2.14[1,4]	1.83	0.88	0.86 – 3.54	3.39[1,2,3]	2.76	1.65	1.99 – 7.81
Age	36	36	8	25 – 47	43	43	11	26 – 58	44	43	6	32 – 50	44	46	7	30 – 52
BMI	27.5	27.4	6.8	21.5 – 45.3	25.9	25.5	5.4	20.0 – 39.3	27.5	28.2	4.5	20.3 – 33.6	29.9	27.8	6.8	21.0 – 41.5
Years Worked	11	7	10	2 – 27	14	13	11	2 – 27	12	6	10	4 – 32	15	17	10	3 – 32
Cigarettes/day	2	0	5	0 – 15	3	0	9	0 – 30	4	0	9	0 – 30	13	5	15	0 – 40
Drinks/day	0.0	0	0.1	0.0 – 0.3	0.1	0.0	0.2	0.0 – 1.0	0.0	0	0.1	0.0 – 0.1	0.1	0.0	0.1	0.0 – 0.3
Cholesterol	184	170	40	138 – 266	202	210	31	139 – 262	206	200	43	161 – 313	209	206	42	129 – 287
HDL	55	56	11	33 – 69	60	58	12	40 – 81	66	66	12	50 – 91	55	55	12	36 – 78
Triglycerides	96	100	49	24 – 198	109	89	58	41 – 233	186	94	281	42 – 1049	142	113	94	46 - 394
Alk Phos	59	61	16	27 – 81	63	58	19	34 – 91	68	69	22	41 – 100	70	70	15	44 – 95
GGT	14	15	6	6 – 26	14	13	6	7 – 30	28	17	27	10 – 97	16	13	9	6 – 39
AST	22	21	8	13 – 43	18	18	5	11 – 26	21	19	9	7 – 39	18	17	5	11 – 30
ALT	20	16	13	9 – 58	18	17	7	11 – 36	22	17	12	6 – 47	17	14	6	10 – 29
Total Bilirubin	0.6	0.6	0.2	0.2 – 0.9	0.6	0.6	0.2	0.3 – 1.0	0.6	0.5	0.1	0.4 – 0.8	0.5	0.5	0.1	0.3 – 0.7
Direct Bilirubin	0.1	0.1	0.1	0.0 – 0.2	0.1	0.1	0.05	0.0 – 0.1	0.1	0.1	0.04	0.0 – 0.1	0.1	0.1	0.05	0.0 – 0.1
BUN	12	13	4	5 – 20	12	13	3	8 – 17	13	13	4	6 – 23	12	13	5	1 – 18
Creatinine	0.8	0.8	0.2	0.6 – 1.1	0.8	0.8	0.1	0.7 – 1.2	0.9	0.9	0.2	0.6 – 1.2	0.9	0.8	0.1	0.7 – 1.1
Glucose	89	90	15	73 – 125	86	86	9	72 – 110	82	85	8	67 – 90	92	89	13	78 - 123

*Number of Female employees by production category by quartile

	Q1	Q2	Q3	Q4
Production	3	1	0	2
Non-Production	9	11	13	10

[1] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 1st quartile
[2] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 2nd quartile
[3] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 3rd quartile
[4] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 4th quartile

Table 22

Decatur Female Production and Non-Production Employee (N = 48)
Thyroid Results* by Quartile of Serum PFOS Distribution**

	Quartile 1 (N = 12)				Quartile 2 (N = 12)				Quartile 3)N = 12)				Quartile 4 (N = 12)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
TSH	2.0	2.0	1.3	0.03 – 4.8	2.6	2.2	1.3	0.7 – 4.6	2.4	2.1	1.2	1.0 – 5.2	2.2	2.2	0.6	1.4 – 3.6
T4	10.0	9.8	2.7	6.5 – 15.1	9.0	8.9	2.0	5.8 – 12.2	9.2	8.9	1.7	6.7 – 11.9	9.1	8.4	2.5	5.8 – 14.2
Free T4	1.0	1.1	0.1	0.9 – 1.3	1.1	1.0	0.1	0.9 – 1.3	1.0	1.0	0.1	0.7 – 1.1	1.0	1.0	0.1	0.8 – 1.2
T3	132	126	26	102 – 188	127	120	29	86 – 176	126	119	26	91 – 168	127	122	32	86 – 196
THBR	28	29	3	24 – 34	28	28	3	23 – 36	26	26	4	22 – 32	28	28	4	18 – 32
FTI	2.7	2.7	0.6	1.7 – 3.8	2.5	2.5	0.5	1.7 – 3.1	2.3	2.4	0.4	1.6 – 2.7	2.4	2.4	0.4	1.8 – 3.0

*No significantly different (P < .05, Bonferroni (Dunn) t test) mean values
**See Table 21 for serum PFOS quartile distribution

Table 23

Decatur Female Production and Non-Production Employee (N = 48)
Hematology Results by Quartile of Serum PFOS Distribution*

	Quartile 1 (N = 12)				Quartile 2 (N = 12)				Quartile 3 (N = 12)				Quartile 4 (N = 12)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
HCT	38	38	3	31 – 43	40	40	2	36 – 43	39	39	1	36 – 41	40	40	4	34 – 49
HGB	12.6	12.7	1.2	9.9 – 14.4	13.3	13.3	0.6	12.3 – 14.5	12.9	12.8	0.5	12.0 – 13.8	13.4	13.4	1.4	11.3 – 16.2
RBC	4.3	4.3	0.3	3.8 – 4.8	4.3	4.3	0.3	3.7 – 4.8	4.4	4.3	0.3	3.9 – 5.0	4.3	4.4	0.4	3.9 – 5.0
WBC	6.7	6.3	2.0	4.2 – 11.7	6.6	6.5	1.9	4.3 – 10.4	5.9	6.2	1.7	2.8 – 8.4	7.6	7.5	1.9	4.2 – 10.4
Platelets	280[3]	260	68	212 – 450	228	216	42	185 – 302	209[1]	206	34	147 – 272	258	254	55	159 - 339

*See Table 21 for serum PFOS quartile distribution
[1] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 1st quartile
[2] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 2nd quartile
[3] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 3rd quartile
[4] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 4th quartile

Table 24

Decatur Female Production and Non-Production Employee (N = 48)
Urinalysis Results by Quartile of Serum PFOS Distribution*

	Quartile 1 N (%)	Quartile 2 N (%)	Quartile 3 N (%)	Quartile 4 N (%)
Albumin	0 (0)	0 (0)	2 (17)	0 (0)
Blood	2 (17)	0 (0)	3 (25)	0 (0)
Sugar	0 (0)	0 (0)	0 (0)	0 (0)

Number of Employees: Q1 = 12; Q2 = 12; Q3 = 12; Q4 = 12
*See Table 21 for serum PFOS quartile distribution

Table 25

Number of Participants (Percent in Parenthesis) Stratified by Antwerp or Decatur Employee Populations Who Had Above Reference Range Values for Hepatic Clinical Chemistry Tests by Quartile of Serum PFOS Distribution

	Alkaline Phosphatase				AST				ALT				GGT				Total Liver Panel*			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Antwerp																				
Male Production[1]	0 (0)	0 (0)	0 (0)	0 (0)	1 (3)	0 (0)	0 (0)	0 (0)	1 (3)	0 (0)	0 (0)	0 (0)	1 (3)	1 (3)	2 (5)	4 (11)	3 (8)	5 (13)	4 (11)	5 (14)
Male Non-Production[2]	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (7)	0 (0)	1 (8)	0 (0)	0 (0)	1 (7)	1 (8)	2 (13)	1 (7)	2 (14)	2 (15)	3 (20)	1 (8)
Female Production[3] and Non-Production	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (8)	0 (0)	0 (0)
Decatur																				
Male Production[4]	1 (3)	2 (6)	2 (6)	1 (3)	0 (0)	1 (3)	0 (0)	4 (10)	3 (8)	5 (13)	3 (8)	11 (28)	4 (10)	3 (8)	2 (6)	6 (15)	7 (18)	8 (20)	7 (18)	14 (35)
Male Non-Production[5]	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (14)	0 (0)	0 (0)	1 (8)	1 (7)	2 (14)	0 (0)	0 (0)	3 (21)	0 (0)	1 (8)	1 (8)	5 (36)	2 (14)	1 (8)
Female Production[6] and Non-Production	0 (0)	0 (0)	0 (0)	0 (0)	1 (8)	0 (0)	0 (0)	0 (0)	1 (8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (17)	0 (0)	1 (8)	0 (0)	2 (17)	0 (0)

*Include Alkaline Phosphate, AST, ALT, GGT, Total and Direct Bilirubin
[1] See Table 4 for serum PFOS quartile distribution
[2] See Table 7 for serum PFOS quartile distribution
[3] See Table 10 for serum PFOS quartile distribution
[4] See Table 13 for serum PFOS quartile distribution
[5] See Table 17 for serum PFOS quartile distribution
[6] See Table 21 for serum PFOS quartile distribution

Table 26

Antwerp and Decatur Male Production and Non-Production* (N = 421)
Fluorochemical, Demographic and Clinical Chemistry Results by Quartile of Serum PFOS Distribution

	Quartile 1 (N = 105)				Quartile 2 (N = 105)				Quartile 3 (N = 106)				Quartile 4 (N = 105)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
PFOS	0.27[2,3,4]	0.29	0.11	0.04 – 0.42	0.60[1,3,4]	0.59	0.12	0.43 – 0.81	1.19[1,2,4]	1.17	0.24	0.82 – 1.68	2.69[1,2,3]	2.46	1.09	1.69 – 10.06
PFOA	0.54[2,3,4]	0.25	0.77	0.01 – 4.03	1.21[1,4]	0.86	1.19	0.06 – 7.04	1.45[1,4]	1.20	1.10	0.12 – 7.48	2.70[1,2,3]	2.43	1.63	0.25 – 12.70
TOF	0.62[2,3,4]	0.43	0.58	0.05 – 3.03	1.40[1,3,4]	1.14	0.89	0.38 – 5.69	2.12[1,2,4]	1.88	0.87	0.98 – 6.61	4.41[1,2,3]	4.06	1.72	1.92 – 12.23
Age	38[3]	36	10	23 – 60	41	40	10	21 – 63	42[1]	43	9	22 – 61	40	40	9	27 – 60
BMI	25.8	25.1	4.0	19.2 – 40.8	26.9	26.3	4.0	19.0 – 37.3	27.3	26.7	4.5	17.2 – 50.1	27.2	26.8	4.5	17.8 – 45.5
Years Worked	12[3]	11	10	1 – 38	15	11	12	2 – 38	16[1]	16	11	1 – 38	15	15	10	2 – 38
Cigarettes/day	4	0	9	0 – 40	5	0	10	0 – 40	6	0	10	0 – 40	6	0	10	0 – 40
Drinks/day	0.9[3,4]	0.7	1.0	0 – 5	0.6	0.3	0.9	0 – 4	0.5[1]	0.1	0.9	0 – 6	0.5[1]	0.0	0.9	0 – 5
Cholesterol	214	209	41	140 – 331	214	217	43	121 – 308	215	216	39	105 – 303	222	214	44	122 – 384
HDL	54	53	15	31 – 121	47	45	11	29 – 80	48	46	13	24 – 100	48	45	15	26 – 119
Triglycerides	131[4]	104	95	32 – 527	155	130	102	35 – 633	169	134	123	32 – 731	177[1]	155	123	39 – 796
Alk Phos	61[3,4]	62	16	26 – 98	67	66	18	30 – 142	69[1]	67	21	30 – 160	70[1]	67	19	21 – 126
GGT	24	20	16	7 – 111	29	22	22	7 – 144	26	23	15	6 – 89	30	25	17	7 – 85
AST	25	24	8	13 – 58	25	24	6	16 – 49	24	24	7	7 – 51	25	24	9	13 – 69
ALT	26[4]	23	13	10 – 91	28	26	11	10 – 63	28	26	14	6 – 103	33[1]	29	19	8 – 99
Total Bilirubin	1.0[3,4]	0.9	0.3	0.5 – 2.0	0.9	0.8	0.3	0.3 – 2.0	0.8[1]	0.8	0.3	0.4 – 2.0	0.8[1]	0.7	0.3	0.4 – 2.2
Direct Bilirubin	0.1	0.1	0.1	0.0 – 0.3	0.1	0.1	0.1	0.0 – 0.7	0.1	0.1	0.1	0.0 – 0.3	0.1	0.1	0.1	0.0 – 0.6
BUN	18	17	7	8 – 71	17	17	4	9 – 30	17	16	5	8 – 31	17	16	5	6 – 30
Creatinine	1.2	1.1	0.5	0.8 – 5.8	1.1	1.1	0.2	0.7 – 1.7	1.3	1.1	1.4	0.8 – 15.0	1.1	1.0	0.2	0.8 – 1.5
Glucose	87	89	16	31 – 131	91	90	17	49 – 184	91	91	17	45 – 168	91	89	30	40 - 331

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Table 26 (continued)

*Number of male employees by location, production category and quartile (percent in parenthesis)

	Quartile 1		Quartile 2		Quartile 3		Quartile 4	
	Production	Non-Production	Production	Non-Production	Production	Non-Production	Production	Non-Production
Antwerp	38	38	38	12	38	4	36	2
Decatur	7	22	40	15	51	13	63	4
Total	45 (43)	60 (57)	78 (74)	27 (26)	89 (84)	27 (16)	99 (94)	6 (6)

[1] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 1st quartile
[2] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 2nd quartile
[3] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 3rd quartile
[4] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 4th quartile

Table 27

Antwerp and Decatur Male Production and Non-Production Employee (N = 421)
Thyroid Results by Quartile of Serum PFOS Distribution*

	Quartile 1 (N = 105)				Quartile 2 (N = 105)				Quartile 3 (N = 106)				Quartile 4 (N = 105)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
TSH	2.0	1.9	1.2	0.03 – 5.7	3.1	2.0	6.6	0.5 – 65.3	2.1	1.7	2.0	0.2 – 18.8	2.5	1.9	2.8	0.5 – 21.5
T4	8.3	8.5	1.4	5.0 – 11.5	8.2	8.4	1.4	4.2 – 12.0	8.3	8.2	1.5	3.3 – 12.9	8.4	8.2	1.4	4.7 – 11.4
Free T4	1.1	1.1	0.2	0.9 – 1.5	1.1	1.1	0.1	0.6 – 1.4	1.1	1.1	0.2	0.4 – 1.6	1.1	1.2	0.2	0.8 – 1.6
T3	124[4]	123	17	94 – 164	128	127	20	86 – 186	127	126	21	91 – 196	132[1]	131	22	87 – 190
THBR	33[3,4]	33	3	26 – 42	32	33	3	24 – 41	32[1]	32	3	25 – 43	32[1]	32	3	25 – 41
FTI	2.7	2.7	0.5	1.7 – 4.2	2.6	2.5	0.4	1.2 – 4.0	2.6	2.6	0.5	1.0 – 4.1	2.6	2.6	0.4	1.6 – 3.6

*See Table 26 for serum PFOS distribution
[1] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 1st quartile
[2] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 2nd quartile
[3] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 3rd quartile
[4] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 4th quartile

Table 28

Antwerp and Decatur Female Production and Non-Production (N = 97)
Fluorochemical, Demographic and Clinical Chemistry Results by Quartile of Serum PFOS Distribution

	Quartile 1 (N = 24)				Quartile 2 (N = 24)				Quartile 3 (N = 25)				Quartile 4 (N = 24)			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
PFOS	0.07[3,4]	0.08	0.02	0.04 – 0.10	0.13[4]	0.13	0.03	0.10 – 0.19	0.39[1]	0.37	0.15	0.20 – 0.70	1.51[1,2,3]	1.34	0.76	0.77 – 3.62
PFOA	0.04[3,4]	0.02	0.04	0.01 – 0.23	0.07[4]	0.05	0.07	0.02 – 0.34	0.61[1]	0.36	0.74	0.04 – 3.50	1.88[1,2,3]	1.39	1.20	0.25 – 5.41
TOF	0.09[3,4]	0.09	0.04	0.05 – 0.26	0.17[3,4]	0.14	0.07	0.09 – 0.35	0.80[1,2,4]	0.59	0.61	0.21 – 3.02	2.77[1,2,3]	2.66	1.44	0.86 – 7.81
Age	34[4]	34	9	24 – 52	37[4]	36	7	25 – 52	39	38	9	25 – 58	44[1,2]	45	6	30 – 52
BMI	22.8[4]	23.4	2.7	18.4 – 28.3	23.9[4]	22.2	4.3	17.3 – 32.3	25.5	23.6	6.1	18.3 – 45.3	28.7[1,2]	27.8	5.7	20.3 – 41.5
Years Worked	11	9	8	1 – 29	15	14	7	3 – 29	12	10	9	2 – 27	14	12	10	3 – 32
Cigarettes/day	1[4]	0	4	0 – 20	2[4]	0	5	0 – 15	2	0	7	0 – 30	8[1,2]	0	13	0 – 40
Drinks/day	0.4[4]	0.3	0.4	0 – 1	0.4[4]	0.3	0.4	0 – 1	0.3	0	0.4	0 – 2	0[1,2]	0	0.1	0 – 1
Cholesterol	207	203	39	132 – 274	203	198	39	138 – 302	200	200	32	139 – 271	208	202	42	129 – 313
HDL	66	61	16	46 – 121	65	64	16	33 – 104	63	61	15	38 – 104	60	58	13	36 – 91
Triglycerides	93	90	48	26 – 248	91	88	41	24 – 172	107	91	53	32 – 233	164	104	206	42 – 1049
Alk Phos	50[4]	52	16	22 – 81	44[3,4]	44	11	20 – 65	59[2]	56	16	32 – 91	69[1,2]	70	18	41 – 100
GGT	11[4]	10	7	2 – 32	13	10	8	5 – 41	14	12	6	7 – 30	22[1]	14	21	6 – 97
AST	19	19	5	11 – 31	18	16	7	9 – 43	19	19	5	11 – 33	19	18	7	7 – 39
ALT	13	12	5	8 – 35	16	13	11	6 – 58	16	15	6	7 – 36	19	16	10	6 – 47
Total Bilirubin	0.8[3,4]	0.8	0.2	0.5 – 1.2	0.8[3,4]	0.8	0.3	0.2 – 1.7	0.6[1,2]	0.6	0.2	0.3 – 1.0	0.5[1,2]	0.5	0.1	0.3 – 0.8
Direct Bilirubin	0.1	0.1	0.1	0.0 – 0.4	0.1	0.1	0.1	0.0 – 0.2	0.1	0.1	0.1	0.0 – 0.2	0.1	0.1	0.04	0.0 – 0.1
BUN	14	13	3	9 – 23	16	16	4	7 – 22	14	14	4	5 – 23	13	13	5	1 – 23
Creatinine	0.9	0.9	0.2	0.6- 1.3	1.0	1.0	0.2	0.7 – 1.4	0.9	0.8	0.1	0.7 – 1.2	0.9	0.8	0.2	0.6 – 1.2
Glucose	80[2]	82	14	38 – 98	93[1]	92	13	65 – 125	85	87	12	49 – 110	87	87	12	67 - 123

Table 28 (continued)

*Number of female employees by location, production category and quartile (percent in parenthesis)

	Quartile 1		Quartile 2		Quartile 3		Quartile 4	
	Production	Non-Production	Production	Non-Production	Production	Non-Production	Production	Non-Production
Antwerp	3	20	2	17	1	6	0	0
Decatur	0	1	1	4	7	11	22	2
Total	3 (12)	21 (88)	3 (12)	21 (88)	8 (32)	17 (68).	22 (92)	2 (8)

[1] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 1st quartile
[2] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 2nd quartile
[3] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 3rd quartile
[4] Mean is significantly different (P < .05, Bonferroni (Dunn) t test) from the mean of the 4th quartile

Table 29

Antwerp and Decatur Female Production and Non-Production Employee (N = 97)
Thyroid Results* by Quartile of Serum PFOS Distribution**

	Quartile 1				Quartile 2				Quartile 3				Quartile 4			
	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range	Mean	Median	SD	Range
TSH	2.2	2.2	1.2	0.03 – 4.9	2.2	2.0	1.5	0.03 – 6.7	2.5	2.1	1.4	0.7 – 6.5	2.3	2.2	1.0	1.0 – 5.2
T4	10.2	10.2	2.0	6.6 – 13.8	9.8	9.8	3.1	4.6 – 18.3	9.9	9.5	2.3	5.8 – 15.1	9.1	8.7	2.1	5.8 – 14.2
Free T4	1.1	1.1	0.1	0.8 – 1.3	1.2	1.1	0.7	0.7 – 4.6	1.1	1.1	0.1	0.9 – 1.3	1.0	1.0	0.1	0.7 – 1.2
T3	145	147	28	98 – 191	147	139	53	81 – 345	133	129	31	86 – 228	127	120	28	86 – 196
THBR	29	29	4	19 – 36	31	32	6	22 – 46	28	27	3	23 – 36	27	27	4	18 – 32
FTI	2.9	2.9	0.5	2.1 – 3.6	3.0	2.8	1.3	1.7 – 8.4	2.7	2.7	0.5	1.7 – 3.8	2.4	2.4	0.4	1.6 – 3.0

*No significantly different ($P < .05$, Bonferroni (Dunn) t test) mean values
**See Table 28 for serum PFOS quartile distribution

Table 30

Number of Participants (Percent in Parenthesis) by Employee Population
Which Had Above Reference Range Values for Hepatic Clinical Chemistry Tests by Quartile of Serum PFOS Distribution

	Alkaline Phosphatase				AST				ALT				GGT				Total Liver Panel*			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Antwerp & Decatur																				
Male Employees																				
Production and[1] Non-Production	0 (0)	1 (1)	3 (3)	2 (2)	3 (3)	1 (1)	1 (1)	4 (4)	4 (4)	4 (4)	7 (7)	13 (12)	6 (6)	8 (8)	6 (6)	12 (12)	15 (14)	17 (16)	17 (16)	24 (23)
Female Employees																				
Production and[2] Non-Production	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (4)	0 (0)	0 (0)	0 (0)	1 (4)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (8)	0 (0)	2 (8)	0 (0)	2 (8)

*Include Alkaline Phosphatase, AST, ALT, GGT, Total and Direct Bilirubin

[1] See Table 26 for serum PFOS quartile distribution
[2] See Table 28 for serum PFOS quartile distribution

Table 31

Multivariable Regression Model of Cholesterol* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	5.072	0.081	.0001	-
PFOS	0.020	0.009	.04	< .01
Production Job (yes/no)	- 0.010	0.023	.66	< .01
Antwerp/Decatur	- 0.025	0.025	.31	< .01
Age	0.006	0.002	.0002	.04
BMI	0.001	0.002	.62	< .01
Cigarettes/day	0.0007	0.001	.49	< .01
Drinks/day	0.035	0.012	.004	.02
Years Worked	- 0.002	0.001	.15	< .01

$R^2 = .08$
Adj $R^2 = .06$
*Natural log

000063

Table 32

Multivariable Regression Model of Cholesterol* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	5.069	0.080	.0001	-
PFOA	0.015	0.008	.05	< .01
Production Job (yes/no)	- 0.012	0.024	.63	< .01
Antwerp/Decatur	- 0.032	0.025	.22	< .01
Age	0.007	0.002	.0001	.05
BMI	0.001	0.002	.64	< .01
Cigarettes/day	0.0006	0.001	.52	< .01
Drinks/day	0.03	0.01	.005	.02
Years Worked	- 0.002	0.001	.21	< .01

$R^2 = .08$
Adj $R^2 = .06$
*Natural log

000064

Table 33

Multivariable Regression Model of Cholesterol* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	5.066	0.081	< .0001	-
PFOS	0.015	0.010	.16	< .01
PFOA	0.009	0.008	.26	< .01
Production Job (yes/no)	- 0.018	0.024	.46	< .01
Antwerp/Decatur	- 0.033	0.025	.20	< .01
Age	0.007	0.002	.0001	.05
BMI	0.001	0.002	.62	< .01
Cigarettes/day	0.0007	0.001	.50	< .01
Drinks/day	0.035	0.012	.004	.02
Years Worked	- 0.002	0.001	.15	.004

$R^2 = .08$
Adj $R^2 = .06$
*Natural log

000065

Table 34

Multivariable Regression Model of Cholesterol* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	5.065	0.081	< .0001	-
TOF	0.015	0.006	.02	< .01
Production Job (yes/no)	- 0.018	0.024	.45	< .01
Antwerp/Decatur	- 0.034	0.025	.18	< .01
Age	0.007	0.002	.0001	.05
BMI	0.001	0.002	.63	< .01
Cigarettes/day	0.0006	0.001	.51	< .01
Drinks/day	0.034	0.012	.005	.02
Years Worked	- 0.002	0.001	.16	< .01

$R^2 = .08$
Adj $R^2 = .07$
*Natural log

Table 35

Multivariable Regression Model of HDL* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	4.313	0.090	< .0001	-
PFOS	- 0.005	0.011	.64	.01
Production Job (yes/no)	0.009	0.026	.73	< .01
Antwerp/Decatur	- 0.059	0.027	.03	.17
Age	0.002	0.002	.37	< .01
BMI	- 0.019	0.003	< .0001	.07
Cigarettes/day	- 0.004	0.001	.0004	.01
Drinks/day	0.083	0.014	< .0001	.06
Years Worked	- 0.001	0.002	.51	< .01

$R^2 = .33$
Adj $R^2 = .32$
*Natural log

Table 36

Multivariable Regression Model of HDL* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	4.326	0.090	<.0001	-
PFOA	- 0.018	0.009	.04	.04
Production Job (yes/no)	0.028	0.027	.30	< .01
Antwerp/Decatur	- 0.043	0.028	.13	.14
Age	0.001	0.002	.50	< .01
BMI	- 0.019	0.003	< .0001	.07
Cigarettes/day	- 0.004	0.001	.0004	.01
Drinks/day	0.084	0.014	< .0001	.06
Years Worked	- 0.001	0.002	.54	< .01

$R^2 = .34$
Adj $R^2 = .32$
*Natural log

Table 37

Multivariable Regression Model of HDL* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	4.324	0.090	< .0001	-
PFOS	0.006	0.012	.60	.01
PFOA	- 0.020	0.010	.04	.03
Production Job (yes/no)	0.025	0.271	.36	< .01
Antwerp/Decatur	- 0.043	0.028	.13	.14
Age	0.001	0.002	.50	< .01
BMI	- 0.019	0.003	< .0001	.07
Cigarettes/day	- 0.004	0.001	.0004	.01
Drinks/day	0.084	0.014	< .0001	.06
Years Worked	- 0.001	0.002	.49	< .01

$R^2 = .34$
Adj $R^2 = .32$
*Natural log

000069

Table 38

Multivariable Regression Model of HDL* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	4.322	0.090	< .0001	-
TOF	- 0.010	0.007	.14	.03
Production Job (yes/no)	0.022	0.027	.41	< .01
Antwerp/Decatur	- 0.050	0.028	.08	.15
Age	0.001	0.002	.45	< .01
BMI	- 0.019	0.003	< .0001	.07
Cigarettes/day	- 0.004	0.001	.0004	.01
Drinks/day	0.084	0.014	< .0001	.06
Years Worked	- 0.0009	0.002	.58	< .01

$R^2 = .33$
Adj $R^2 = .32$
*Natural log

Table 39

Multivariable Regression Model of Triglycerides* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.768	0.224	< .0001	-
PFOS	0.066	0.026	.01	.03
Production Job (yes/no)	0.023	0.065	.72	< .01
Antwerp/Decatur	0.151	0.068	.03	.10
Age	0.013	0.005	.009	.02
BMI	0.055	0.007	< .0001	.10
Cigarettes/day	0.008	0.003	.002	.02
Drinks/day	0.033	0.034	.33	< .01
Years Worked	- 0.007	0.004	.07	< .01

R^2 = .28
Adj R^2 = .27
*Natural log

Table 40

Multivariable Regression Model of Triglycerides* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.742	0.224	< .0001	-
PFOA	0.066	0.021	.002	.05
Production Job (yes/no)	- 0.004	0.066	.95	< .01
Antwerp/Decatur	0.111	0.070	.12	.08
Age	0.014	0.005	.005	.02
BMI	0.055	0.007	< .0001	.10
Cigarettes/day	0.008	0.003	.003	.02
Drinks/day	0.029	0.034	.15	< .01
Years Worked	- 0.007	0.004	.11	.005

$R^2 = .29$
Adj $R^2 = .27$
*Natural log

Table 41

Multivariable Regression Model of Triglycerides* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.734	0.224	< .0001	-
PFOS	0.037	0.029	.20	.03
PFOA	0.053	0.023	.02	.02
Production Job (yes/no)	- 0.021	0.067	.76	< .01
Antwerp/Decatur	0.109	0.070	.12	.08
Age	0.014	0.005	.004	.02
BMI	0.055	0.007	< .0001	.10
Cigarettes/day	0.008	0.003	.002	.02
Drinks/day	0.030	0.034	.15	< .01
Years Worked	- 0.007	0.004	.07	< .01

$R^2 = .29$
Adj $R^2 = .27$
*Natural log

000073

Table 42

Multivariable Regression Model of Triglycerides* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.736	0.223	< .0001	-
TOF	0.056	0.017	.0009	.06
Production Job (yes/no)	- 0.017	0.067	.81	< .01
Antwerp/Decatur	0.113	0.070	.10	.08
Age	0.014	0.005	.005	.02
BMI	0.055	0.007	< .0001	.10
Cigarettes/day	0.008	0.003	.002	.02
Drinks/day	0.030	0.034	.37	< .01
Years Worked	- 0.007	0.004	.07	< .01

$R^2 = .29$
Adj $R^2 = .27$
*Natural log

Table 43

Multivariable Regression Model of Alkaline Phosphatase* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	3.718	0.362	< .0001	-
PFOS	0.013	0.013	.32	.02
Production Job (yes/no)	0.036	0.032	.26	< .01
Antwerp/Decatur	0.149	0.034	< .0001	.11
Age	0.0008	0.002	.73	< .01
BMI	- 0.004	0.004	.26	< .01
Cigarettes/day	0.002	0.001	.17	< .01
Drinks/day	- 0.024	0.016	.14	< .01
Years Worked	- 0.002	0.002	.41	< .01
Triglycerides*	0.083	0.024	.0006	.02

$R^2 = .18$
Adj $R^2 = .16$
*Natural log

Table 44

Multivariable Regression Model of Alkaline Phosphatase* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	3.746	0.128	< .0001	-
PFOA	0.0001	0.010	.99	.03
Production Job (yes/no)	0.047	0.032	.15	< .01
Antwerp/Decatur	0.154	0.035	< .0001	.10
Age	0.0006	0.002	.80	< .01
BMI	- 0.004	0.004	.24	< .01
Cigarettes/day	0.002	0.001	.18	< .01
Drinks/day	- 0.024	0.017	.14	< .01
Years Worked	- 0.001	0.002	.52	< .01
Triglycerides*	0.086	0.024	.0004	.03

$R^2 = .18$
Adj $R^2 = .16$
*Natural log

000076

Table 45

Multivariable Regression Model of Alkaline Phosphatase* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	3.747	0.128	< .0001	-
PFOS	0.015	0.014	.28	.02
PFOA	- 0.005	0.012	.65	< .01
Production Job (yes/no)	0.040	0.033	.23	< .01
Antwerp/Decatur	0.153	0.034	< .0001	.10
Age	0.0007	0.002	.78	< .01
BMI	- 0.004	0.004	.25	< .01
Cigarettes/day	0.002	0.001	.17	< .01
Drinks/day	- 0.024	0.017	.15	< .01
Years Worked	- 0.002	0.002	.42	< .01
Triglycerides*	0.085	0.024	.0005	.02

$R^2 = .18$
Adj $R^2 = .16$
*Natural log

000077

Table 46

Multivariable Regression Model of Alkaline Phosphatase* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Alk Phos			
	Parameter	SE	p value	Partial R^2
Intercept	3.747	0.128	< .0001	-
TOF	0.006	0.008	.47	.04
Production Job (yes/no)	0.037	0.033	.27	< .01
Antwerp/Decatur	0.147	0.034	< .0001	.10
Age	0.0008	0.002	.72	< .01
BMI	- 0.004	0.004	.25	< .01
Cigarettes/day	0.002	0.001	.18	< .01
Drinks/day	- 0.024	0.016	.14	< .01
Years Worked	- 0.002	0.002	.45	< .01
Triglycerides*	0.084	0.024	.0006	.02

$R^2 = .18$
Adj $R^2 = .16$
*Natural log

000078

Table 47

Multivariable Regression Model of GGT* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.246	0.239	< .0001	-
PFOS	0.028	0.024	.24	.03
Production Job (yes/no)	- 0.003	0.059	.96	< .01
Antwerp/Decatur	0.255	0.063	< .0001	.07
Age	0.0003	0.004	.95	< .01
BMI	0.006	0.007	.36	.02
Cigarettes/day	0.003	0.003	.28	.01
Drinks/day	0.117	0.031	.0002	.03
Years Worked	0.002	0.004	.45	< .01
Triglycerides*	0.294	0.045	< .0001	.08

$R^2 = .25$
Adj $R^2 = .23$
*Natural log

000079

Table 48

Multivariable Regression Model of GGT* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.245	0.238	< .0001	-
PFOA	0.032	0.019	0.10	.04
Production Job (yes/no)	- 0.020	0.060	.74	< .01
Antwerp/Decatur	0.235	0.065	.0003	.06
Age	0.0009	0.004	.84	.01
BMI	0.006	0.007	.35	.02
Cigarettes/day	0.003	0.003	.28	.01
Drinks/day	0.116	0.031	.0002	.03
Years Worked	0.003	0.004	.40	< .01
Triglycerides*	0.289	0.045	< .0001	.08

$R^2 = .25$
Adj $R^2 = .23$
*Natural log

Table 49

Multivariable Regression Model of GGT* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.246	0.239	< .0001	-
PFOS	0.014	0.027	.60	.03
PFOA	0.028	0.021	.20	.02
Production Job (yes/no)	- 0.026	0.062	.67	< .001
Antwerp/Decatur	0.23	0.065	.0003	.06
Age	0.0009	0.004	.82	.01
BMI	0.006	0.007	.34	.02
Cigarettes/day	0.003	0.003	.27	.01
Drinks/day	0.116	0.031	.0002	.03
Years Worked	0.003	0.004	.46	< .01
Triglycerides*	0.288	0.045	< .0001	.08

R^2 = .25
Adj R^2 = .23
*Natural log

000081

Table 50

Multivariable Regression Model of GGT* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.246	0.238	< .0001	-
TOF	0.029	0.016	.06	.04
Production Job (yes/no)	- 0.028	0.061	.64	< .01
Antwerp/Decatur	0.235	0.064	.0003	.06
Age	0.001	0.004	.82	.01
BMI	0.006	0.007	.33	.02
Cigarettes/day	0.003	0.003	.28	.01
Drinks/day	0.116	0.031	.0002	.03
Years Worked	0.003	0.003	.48	< .01
Triglycerides*	0.288	0.045	< .0001	.07

$R^2 = .25$
Adj $R^2 = .24$
*Natural log

000082

Table 51

Multivariable Regression Model of AST* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.725	0.133	< .0001	-
PFOS	0.013	0.013	.33	< .01
Production Job (yes/no)	- 0.022	0.033	.50	< .01
Antwerp/Decatur	0.114	0.035	.001	.03
Age	0.003	0.002	.28	< .01
BMI	0.002	0.004	.53	< .01
Cigarettes/day	- 0.003	0.001	.04	< .01
Drinks/day	0.052	0.017	.002	.02
Years Worked	- 0.004	0.002	.05	.01
Triglycerides*	0.055	0.025	.03	.01

$R^2 = .09$
Adj $R^2 = .07$
*Natural log

Table 52

Multivariable Regression Model of AST* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.725	0.133	< .0001	-
PFOA	0.015	0.011	.17	.01
Production Job (yes/no)	- 0.030	0.034	.37	< .01
Antwerp/Decatur	0.105	0.036	.004	.02
Age	0.003	0.002	.23	< .01
BMI	0.002	0.004	.51	< .01
Cigarettes/day	- 0.003	0.001	.04	< .01
Drinks/day	0.051	0.017	.003	.02
Years Worked	- 0.004	0.002	.05	.01
Triglycerides*	0.053	0.025	.04	< .01

$R^2 = .09$
Adj $R^2 = .07$
*Natural log

000084

Table 53

Multivariable Regression Model of AST* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.725	0.132	< .0001	-
PFOS	0.006	0.015	.68	< .01
PFOA	0.013	0.012	.28	< .01
Production Job (yes/no)	- 0.033	0.034	.34	< .01
Antwerp/Decatur	0.104	0.036	.004	.02
Age	0.003	0.002	.23	< .01
BMI	0.002	0.004	.50	< .01
Cigarettes/day	- 0.003	0.001	.04	< .01
Drinks/day	0.052	0.017	.003	.02
Years Worked	- 0.004	0.002	.04	.01
Triglycerides*	0.052	0.025	.04	< .01

$R^2 = .09$
Adj $R^2 = .07$
*Natural log

000085

Table 54

Multivariable Regression Model of AST* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.725	0.133	< .0001	-
TOF	0.011	0.009	.17	.01
Production Job (yes/no)	- 0.031	0.034	.36	< .01
Antwerp/Decatur	0.106	0.036	.003	.02
Age	0.003	0.002	.24	< .01
BMI	0.002	0.004	.51	< .01
Cigarettes/day	- 0.003	0.001	.04	< .01
Drinks/day	0.052	0.017	.003	.02
Years Worked	- 0.004	0.002	.04	.01
Triglycerides*	0.053	0.025	.04	< .01

$R^2 = .09$
Adj $R^2 = .07$
*Natural log

Table 55

Multivariable Regression Model of ALT* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.744	0.165	< .0001	-
PFOS	0.021	0.018	.25	.01
Production Job (yes/no)	0.017	0.043	.69	< .01
Antwerp/Decatur	0.172	0.042	< .0001	.06
Age	- 0.002	0.003	.50	< .01
BMI	0.025	0.004	< .0001	.13
Cigarettes/day	- 0.007	0.002	.0003	.01
Drinks/day	- 0.006	0.024	.79	< .01
Years Worked	- 0.004	0.002	.10	< .01
Triglycerides*	0.189	0.032	< .0001	.05

$R^2 = .27$
Adj $R^2 = .25$
*Natural log

Table 56

Multivariable Regression Model of ALT* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.761	0.165	< .0001	-
PFOA	0.005	0.003	.13	< .01
Production Job (yes/no)	0.027	0.041	.51	< .01
Antwerp/Decatur	0.186	0.041	< .0001	.07
Age	- 0.002	0.003	.44	< .01
BMI	0.024	0.004	< .0001	.12
Cigarettes/day	- 0.007	0.002	.0002	.01
Drinks/day	- 0.005	0.024	.83	< .01
Years Worked	- 0.004	0.002	.15	< .01
Triglycerides*	0.190	0.032	< .0001	.05

$R^2 = .27$
Adj $R^2 = .25$
*Natural log

Table 57

Multivariable Regression Model of ALT* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.757	0.165	< .0001	-
PFOS	0.019	0.018	.29	.01
PFOA	0.004	0.003	.15	< .01
Production Job (yes/no)	0.013	0.043	.76	< .01
Antwerp/Decatur	0.176	0.042	< .0001	.06
Age	- 0.002	0.003	.50	< .01
BMI	0.025	0.004	< .0001	.12
Cigarettes/day	- 0.007	0.002	.0003	< .01
Drinks/day	- 0.006	0.024	.80	< .01
Years Worked	- 0.004	0.002	.11	< .01
Triglycerides*	0.187	0.032	< .0001	.05

$R^2 = .27$
Adj $R^2 = .26$
*Natural log

000089

Table 58

Multivariable Regression Model of ALT* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.965	0.193	< .0001	-
TOF	0.029	0.013	.02	.06
Production Job (yes/no)	- 0.054	0.050	.27	< .01
Antwerp/Decatur	0.296	0.051	< .0001	.15
Age	- 0.003	0.004	.38	< .01
BMI	0.012	0.005	.02	.04
Cigarettes/day	- 0.007	0.002	.0003	.01
Drinks/day	0.01	0.025	.62	< .01
Years Worked	- 0.002	0.003	.44	< .01
Triglycerides*	0.199	0.04	< .0001	.05

$R^2 = .32$
Adj $R^2 = .31$
*Natural log

Table 59

Multivariable Regression Model of Total Bilirubin* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	0.209	0.145	< .0001	-
PFOS	- 0.017	0.015	.25	.03
Production Job (yes/no)	- 0.068	0.036	.06	.01
Antwerp/Decatur	- 0.262	0.038	< .0001	.18
Age	0.001	0.003	.58	< .01
BMI	- 0.005	0.004	.19	< .01
Cigarettes/day	- 0.008	0.002	< .0001	.06
Drinks/day	0.005	0.02	.80	< .01
Years Worked	0.0002	0.002	.94	< .01
Triglycerides*	- 0.015	0.027	.57	< .01

$R^2 = .29$
Adj $R^2 = .27$
*Natural log

000091

Table 60

Multivariable Regression Model of Total Bilirubin* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	0.210	0.145	< .0001	-
PFOA	- 0.004	0.011	.74	.05
Production Job (yes/no)	- 0.078	0.037	.04	.01
Antwerp/Decatur	- 0.265	0.039	< .0001	.17
Age	0.002	0.003	.54	< .01
BMI	- 0.005	0.004	.21	< .01
Cigarettes/day	- 0.008	0.002	< .0001	.06
Drinks/day	0.005	0.019	.80	< .01
Years Worked	- 0.0002	0.002	.91	< .01
Triglycerides*	- 0.018	0.027	.52	< .01

$R^2 = .29$
Adj $R^2 = .2$
*Natural log

Table 61

Multivariable Regression Model of Total Bilirubin* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	0.209	0.144	< .0001	-
PFOS	- 0.018	0.016	.27	.03
PFOA	0.002	0.013	.86	.02
Production Job (yes/no)	- 0.070	0.037	.063	.01
Antwerp/Decatur	- 0.264	0.039	< .0001	.16
Age	0.002	0.003	.57	< .01
BMI	- 0.005	0.004	.20	< .01
Cigarettes/day	- 0.008	0.002	< .0001	.06
Drinks/day	0.005	0.002	.81	< .01
Years Worked	0.0002	0.002	.95	< .01
Triglycerides*	- 0.016	0.027	.56	< .01

$R^2 = .29$
Adj $R^2 = .27$
*Natural log

000093

Table 62

Multivariable Regression Model of Total Bilirubin* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	0.210	0.144	< .0001	-
TOF	- 0.011	0.009	.25	.06
Production Job (yes/no)	- 0.064	0.037	.09	.01
Antwerp/Decatur	- 0.257	0.039	< .0001	.16
Age	0.001	0.003	.62	< .01
BMI	- 0.005	0.004	.19	< .01
Cigarettes/day	- 0.008	0.002	< .0001	.06
Drinks/day	0.005	0.019	.78	< .01
Years Worked	0.00007	0.002	.98	< .01
Triglycerides*	- 0.014	0.027	.60	< .01

R^2 = .29
Adj R^2 = .27
*Natural log

000094

Table 63

Multivariable Regression Model of TSH* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	- 0.539	0.327	.10	-
PFOS	0.015	0.033	.65	< .01
Production Job (yes/no)	0.109	0.081	.18	< .01
Antwerp/Decatur	0.184	0.086	.03	.02
Age	0.005	0.006	.36	< .01
BMI	- 0.005	0.009	.56	< .01
Cigarettes/day	- 0.005	0.003	.17	< .01
Drinks/day	0.057	0.042	.17	< .01
Years Worked	- 0.008	0.005	.13	< .01
Triglycerides*	0.204	0.061	.001	.02

$R^2 = .07$
Adj $R^2 = .05$
*Natural log

Table 64

Multivariable Regression Model of TSH* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	- 0.539	0.327	.10	-
PFOA	0.018	0.027	.51	.02
Production Job (yes/no)	0.100	0.083	.23	< .01
Antwerp/Decatur	0.173	0.088	.051	< .01
Age	0.006	0.006	.33	< .01
BMI	- 0.005	0.009	.56	< .01
Cigarettes/day	- 0.005	0.003	.17	< .01
Drinks/day	0.056	0.042	.18	< .01
Years Worked	- 0.008	0.005	.13	< .01
Triglycerides*	0.201	0.062	.001	.02

$R^2 = .07$
Adj $R^2 = .05$
*Natural log

Table 65

Multivariable Regression Model of TSH* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	- 0.539	0.327	.10	-
PFOS	0.007	0.036	.85	< .01
PFOA	0.015	0.029	.61	< .01
Production Job (yes/no)	0.096	0.084	.25	< .01
Antwerp/Decatur	0.173	0.089	.05	< .01
Age	0.006	0.006	.33	< .01
BMI	- 0.005	0.009	.57	< .01
Cigarettes/day	- 0.005	0.003	.17	< .01
Drinks/day	0.056	0.042	.18	< .01
Years Worked	- 0.008	0.005	.13	< .01
Triglycerides*	0.200	0.062	.001	.02

$R^2 = .07$
Adj $R^2 = .05$
*Natural log

Table 66

Multivariable Regression Model of TSH* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	- 0.539	0.327	.10	-
TOF	0.015	0.021	.49	.02
Production Job (yes/no)	0.097	0.084	.25	< .01
Antwerp/Decatur	.174	0.088	.05	.01
Age	0.006	0.006	.33	< .01
BMI	- 0.005	0.009	.57	< .01
Cigarettes/day	- 0.005	0.003	.17	< .01
Drinks/day	0.056	0.042	.18	< .01
Years Worked	- 0.008	0.005	.12	< .01
Triglycerides*	0.201	0.062	.001	.02

$R^2 = .07$
Adj $R^2 = .05$
*Natural log

000098

Table 67

Multivariable Regression Model of T4* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.263	0.090	< .001	-
PFOS	- 0.003	0.009	.78	< .01
Production Job (yes/no)	- 0.003	0.022	.91	< .01
Antwerp/Decatur	0.011	0.024	.64	< .01
Age	- 0.003	0.002	.08	< .01
BMI	0.001	0.003	.66	< .01
Cigarettes/day	0.0009	0.0009	.32	< .01
Drinks/day	- 0.024	0.012	.04	< .01
Years Worked	0.001	0.001	.35	< .01
Triglycerides*	- 0.018	0.017	.29	< .01

$R^2 = .02$
Adj $R^2 = .01$
*Natural log

Table 68

Multivariable Regression Model of T4* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.263	0.090	< .0001	-
PFOA	0.0003	0.007	.97	< .01
Production Job (yes/no)	- 0.005	0.023	.82	< .01
Antwerp/Decatur	0.010	0.024	.69	< .01
Age	- 0.003	0.002	.09	< .01
BMI	0.001	0.003	.64	< .01
Cigarettes/day	0.001	0.0009	.31	< .01
Drinks/day	-0.02	0.01	.04	< .01
Years Worked	0.001	0.001	.37	< .01
Triglycerides*	- 0.019	0.017	.28	< .01

$R^2 = .03$
Adj $R^2 = .01$
*Natural log

000100

Table 69

Multivariable Regression Model of T4* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.263	0.090	< .0001	-
PFOS	- 0.003	0.010	.74	< .01
PFOA	0.001	0.008	.86	< .01
Production Job (yes/no)	- 0.004	0.023	.87	< .01
Antwerp/Decatur	0.010	0.024	.68	< .01
Age	- 0.003	0.002	.09	< .01
BMI	0.001	0.003	.65	< .01
Cigarettes/day	0.0009	0.0009	.32	< .01
Drinks/day	- 0.024	0.012	.04	< .01
Years Worked	0.001	0.001	.35	< .01
Triglycerides*	- 0.018	0.017	.29	< .01

$R^2 = .03$
Adj $R^2 = < .01$
*Natural log

000101

Table 70

Multivariable Regression Model of T4* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	2.263	0.090	< .0001	-
TOF	0.0002	0.006	.97	< .01
Production Job (yes/no)	- 0.005	0.023	.82	< .01
Antwerp/Decatur	0.010	0.024	.68	< .01
Age	- 0.003	0.002	.09	< .01
BMI	0.001	0.003	.64	< .01
Cigarettes/day	0.001	0.0009	.31	< .01
Drinks/day	- 0.024	0.012	.04	< .01
Years Worked	0.001	0.001	.37	< .01
Triglycerides*	- 0.019	0.017	.28	< .01

$R^2 = .03$
Adj $R^2 = < .01$
*Natural log

000102

Table 71

Multivariable Regression Model of Free T4* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	0.299	0.076	< .0001	-
PFOS	- 0.004	0.008	.63	< .01
Production Job (yes/no)	- 0.030	0.019	.11	< .01
Antwerp/Decatur	- 0.021	0.020	.28	.03
Age	- 0.003	0.001	.03	.01
BMI	- 0.003	0.002	.13	< .01
Cigarettes/day	- 0.0009	0.0008	.27	< .01
Drinks/day	0.006	0.010	.56	< .01
Years Worked	0.002	0.001	.21	< .01
Triglycerides*	0.003	0.014	.85	< .01

$R^2 = .06$
Adj $R^2 = .04$
*Natural log

Table 72

Multivariable Regression Model of Free T4* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	0.299	0.076	.0001	-
PFOA	- 0.006	0.006	.31	.01
Production Job (yes/no)	- 0.025	0.019	.19	< .01
Antwerp/Decatur	- 0.017	0.021	.41	.02
Age	- 0.003	0.001	.02	.01
BMI	- 0.003	0.002	.13	< .01
Cigarettes/day	- 0.0009	0.0008	.27	< .01
Drinks/day	0.006	0.010	.53	< .01
Years Worked	0.002	0.001	.20	< .01
Triglycerides*	0.004	0.014	.78	< .01

$R^2 = .07$
Adj $R^2 = .04$
*Natural log

000104

Table 73

Multivariable Regression Model of Free T4* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	0.299	0.076	.0001	-
PFOS	- 0.0005	0.008	.96	< .01
PFOA	- 0.006	0.007	.37	< .01
Production Job (yes/no)	- 0.025	0.020	.21	< .01
Antwerp/Decatur	- 0.020	0.210	.41	.02
Age	- 0.003	0.001	.02	.01
BMI	- 0.003	0.002	.13	< .01
Cigarettes/day	- 0.0009	0.0008	.27	.002
Drinks/day	0.006	0.010	.54	< .01
Years Worked	0.002	0.001	.20	< .01
Triglycerides*	0.004	0.014	.77	< .01

$R^2 = .07$
Adj $R^2 = .04$
*Natural log

000105

Table 74

Multivariable Regression Model of Free T4* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	0.299	0.076	.0001	-
TOF	- 0.004	0.005	.37	.01
Production Job (yes/no)	- 0.025	0.020	.19	< .01
Antwerp/Decatur	- 0.018	0.020	.38	.02
Age	- 0.003	0.001	.02	.01
BMI	- 0.003	0.002	.13	< .01
Cigarettes/day	- 0.0009	0.0008	.27	< .01
Drinks/day	0.006	0.010	.01	< .01
Years Worked	0.002	0.001	.19	< .01
Triglycerides*	0.004	0.014	.79	< .01

$R^2 = .06$
Adj $R^2 = .04$
*Natural log

Table 75

Multivariable Regression Model of THBR* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	3.589	0.041	< .0001	-
PFOS	- 0.003	0.004	.40	.03
Production Job (yes/no)	- 0.006	0.010	.55	< .01
Antwerp/Decatur	- 0.090	0.011	< .0001	.30
Age	- 0.0005	0.0008	.50	< .01
BMI	- 0.001	0.001	.29	< .01
Cigarettes/day	- 0.0007	0.0004	.13	< .01
Drinks/day	- 0.015	0.005	.005	.01
Years Worked	- 0.0002	0.0007	.77	< .01
Triglycerides*	- 0.003	0.008	.75	< .01

$R^2 = .35$
Adj $R^2 = .34$
*Natural log

Table 76

Multivariable Regression Model of THBR* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	3.589	0.041	< .0001	-
PFOA	- 0.003	0.003	.43	.04
Production Job (yes/no)	- 0.006	0.010	.58	< .01
Antwerp/Decatur	- 0.089	0.011	< .0001	.28
Age	- 0.0005	0.0008	.48	< .01
BMI	- 0.001	0.001	.29	< .01
Cigarettes/day	- 0.0007	0.0004	.13	< .01
Drinks/day	0.015	0.005	.004	.01
Years Worked	- 0.0002	0.0006	.71	< .01
Triglycerides*	- 0.002	0.008	.76	< .01

R^2 = .35
Adj R^2 = .34
*Natural log

Table 77

Multivariable Regression Model of THBR* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	3.589	0.041	< .0001	-
PFOS	- 0.003	0.005	.58	.03
PFOA	- 0.002	0.004	.64	.02
Production Job (yes/no)	- 0.005	0.011	.66	< .01
Antwerp/Decatur	- 0.088	0.011	< .0001	.28
Age	- 0.0006	0.0008	.47	< .01
BMI	- 0.001	0.001	.28	< .01
Cigarettes/day	- 0.0007	0.0004	.13	< .01
Drinks/day	0.015	0.005	.004	.01
Years Worked	- 0.0002	0.0007	.78	< .01
Triglycerides*	- 0.002	0.008	.79	< .01

$R^2 = .35$
Adj $R^2 = .34$
*Natural log

000109

Table 78

Multivariable Regression Model of THBR* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	3.589	0.041	< .0001	-
TOF	- 0.003	0.003	.29	.05
Production Job (yes/no)	- 0.004	0.011	.69	< .01
Antwerp/Decatur	- 0.088	0.011	< .0001	.28
Age	- 0.0006	0.0008	.45	< .01
BMI	- 0.001	0.001	.28	< .01
Cigarettes/day	- 0.0007	0.0004	.13	< .01
Drinks/day	0.015	0.005	.004	.01
Years Worked	- 0.0002	0.0007	.77	< .01
Triglycerides*	- 0.002	0.008	.80	< .01

$R^2 = .35$
Adj $R^2 = .34$
*Natural log

000110

Table 79

Multivariable Regression Model of FTI* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.239	0.085	< .0001	-
PFOS	- 0.006	0.009	.45	.01
Production Job (yes/no)	- 0.009	0.021	.65	< .01
Antwerp/Decatur	- 0.078	0.022	.0004	.07
Age	- 0.003	0.002	.03	.02
BMI	- 0.0001	0.002	.96	< .01
Cigarettes/day	0.0002	0.0009	.82	< .01
Drinks/day	- 0.008	0.011	.44	< .01
Years Worked	0.001	0.001	.41	< .01
Triglycerides*	- 0.022	0.016	.16	< .01

$R^2 = .10$
Adj $R^2 = .08$
*Natural log

000111

Table 80

Multivariable Regression Model of FTI* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.239	0.085	< .0001	-
PFOA	- 0.002	0.007	.77	.01
Production Job (yes/no)	- 0.012	0.021	.56	< .01
Antwerp/Decatur	- 0.079	0.023	.0006	.07
Age	- 0.003	0.002	.03	.02
BMI	- 0.00007	0.002	.98	< .01
Cigarettes/day	0.0002	0.0009	.80	< .01
Drinks/day	- 0.008	0.011	.44	< .01
Years Worked	0.001	0.001	.47	< .01
Triglycerides*	- 0.023	0.016	.15	< .01

$R^2 = .10$
Adj $R^2 = .08$
*Natural log

000112

Table 81

Multivariable Regression Model of FTI* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.239	0.085	< .0001	-
PFOS	- 0.006	0.009	.49	.01
PFOA	0.0002	0.008	.98	< .01
Production Job (yes/no)	- 0.010	0.022	.66	< .01
Antwerp/Decatur	- 0.079	0.023	.0007	.06
Age	- 0.003	0.002	.03	.02
BMI	- 0.0001	0.002	.96	.02
Cigarettes/day	0.0002	0.0009	.82	< .01
Drinks/day	- 0.008	0.011	.44	< .01
Years Worked	0.001	0.001	.41	.002
Triglycerides*	- 0.022	0.016	.17	.004

$R^2 = .10$
Adj $R^2 = .08$
*Natural log

Table 82

Multivariable Regression Model of FTI* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	1.239	0.085	< .0001	-
TOF	- 0.003	0.006	.62	.01
Production Job (yes/no)	- 0.010	0.022	.63	< .01
Antwerp/Decatur	- 0.078	0.023	.0007	.06
Age	- 0.003	0.002	.03	.02
BMI	- 0.0001	0.002	.97	< .01
Cigarettes/day	0.0002	0.0009	.81	< .01
Drinks/day	- 0.008	0.011	.44	< .01
Years Worked	0.001	0.001	.44	< .01
Triglycerides*	- 0.022	0.016	.16	< .01

$R^2 = .10$
Adj $R^2 = .08$
*Natural log

000114

Table 83

Multivariable Regression Model of T3* by PFOS
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	4.702	0.074	< .0001	-
PFOS	0.015	0.007	.04	.01
Production Job (yes/no)	0.022	0.018	.23	.01
Antwerp/Decatur	- 0.099	0.019	< .0001	.03
Age	- 0.002	0.001	.24	< .01
BMI	0.005	0.002	.02	.02
Cigarettes/day	0.003	0.0008	.001	.02
Drinks/day	- 0.027	0.009	.004	.02
Years Worked	- 0.0006	0.001	.60	< .01
Triglycerides*	0.020	0.014	.15	< .01

$R^2 = .12$
Adj $R^2 = .10$
*Natural log

Table 84

Multivariable Regression Model of T3* by PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	4.702	0.073	< .0001	-
PFOA	0.016	0.006	.01	.02
Production Job (yes/no)	0.015	0.019	.41	< .01
Antwerp/Decatur	- 0.109	0.020	< .0001	.03
Age	- 0.001	0.001	.33	< .01
BMI	0.005	0.002	.02	.02
Cigarettes/day	0.003	0.0008	.001	.02
Drinks/day	- 0.028	0.009	.003	.02
Years Worked	- 0.0004	0.001	.70	< .01
Triglycerides*	0.018	0.014	.20	< .01

$R^2 = .13$
Adj $R^2 = .11$
*Natural log

Table 85

Multivariable Regression Model of T3* by PFOS and PFOA
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	4.703	0.073	< .0001	-
PFOS	0.009	0.008	.29	.01
PFOA	0.013	0.007	.05	< .01
Production Job (yes/no)	0.012	0.019	.54	< .01
Antwerp/Decatur	- 0.109	0.020	< .0001	.03
Age	- 0.001	0.001	.35	< .01
BMI	0.005	0.002	.01	.02
Cigarettes/day	0.003	0.0008	.001	.02
Drinks/day	- 0.028	0.009	.003	.02
Years Worked	- 0.0006	0.001	.59	< .01
Triglycerides*	0.017	0.014	.23	< .01

$R^2 = .13$
Adj $R^2 = .11$
*Natural log

000117

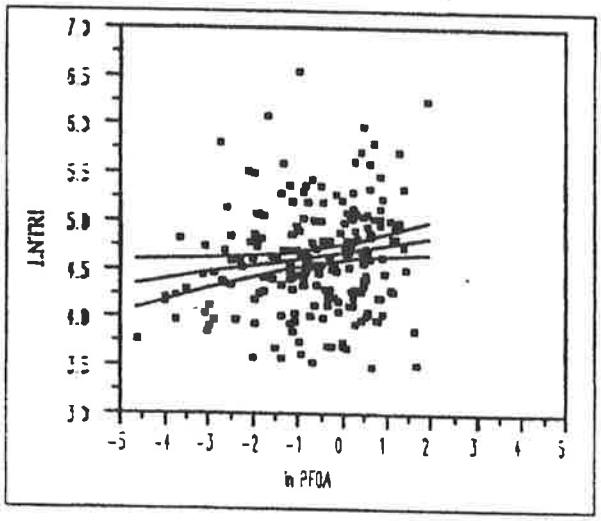
Table 86

Multivariable Regression Model of T3* by TOF
and Other Potential Explanatory Variables
for Antwerp and Decatur Male Employee Participants,
2000 Medical Surveillance Program

	Parameter	SE	p value	Partial R^2
Intercept	4.702	0.073	< .0001	-
TOF	0.014	0.005	.004	.02
Production Job (yes/no)	0.011	0.019	.54	< .01
Antwerp/Decatur	- 0.109	0.020	< .0001	.03
Age	- 0.001	0.001	.35	< .01
BMI	0.005	0.002	.01	.02
Cigarettes/day	0.003	0.0007	.001	.02
Drinks/day	- 0.028	0.009	.003	.02
Years Worked	- 0.0007	0.001	.56	< .01
Triglycerides*	0.017	0.014	.22	< .01

$R^2 = .13$
Adj $R^2 = .11$
*Natural log

Figure 1. Linear Regression Model of Triglycerides* by PFOA* for Antwerp Male Employees, 2000 Medical Surveillance Program



Summary of Fit

RSquare	0.029

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	1.863	1.863	6.211
Error	204	61.193	0.299	Prob>F
C Total	205	63.056		0.014

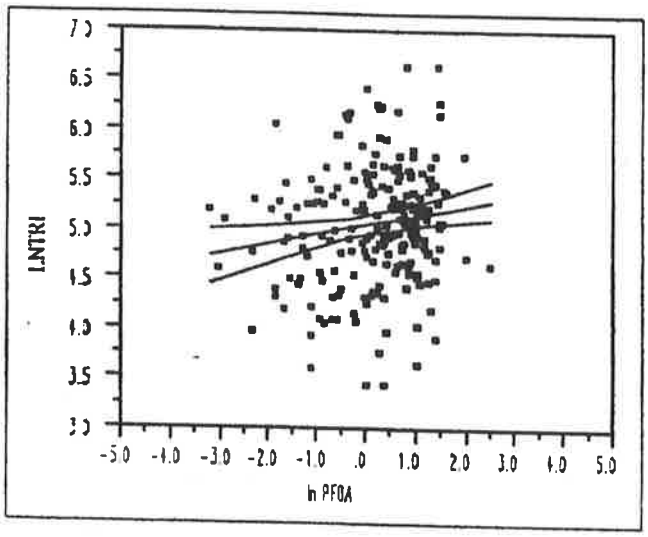
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.695	0.042	111.43	<.0001
ln PFOA	0.073	0.029	2.49	0.014

*natural log

000119

Figure 2. Linear Regression of Triglycerides* by PFOA* for Decatur Male Employees, 2000 Medical Surveillance Program



Summary of Fit

RSquare	0.028

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	2.164	2.164	6.232
Error	213	73.969	0.347	Prob>F
C Total	214	76.133		0.013

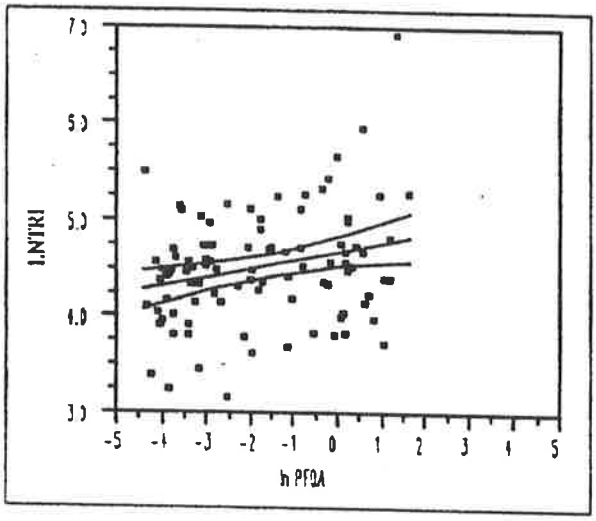
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	5.052	0.041	122.27	<.0001
ln PFOA	0.098	0.039	2.50	0.013

*natural log

000120

Figure 3. Linear Regression of Triglycerides* by PFOA* for Antwerp and Decatur Female Employees, 2000 Medical Surveillance Program



Summary of Fit

RSquare	0.078

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	2.519	2.519	8.010
Error	95	29.877	0.314	Prob>F
C Total	96	32.396		0.006

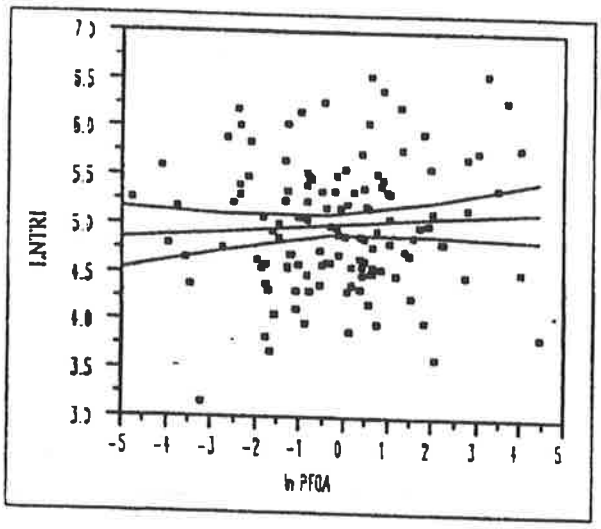
Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	4.690	0.081	58.14	<.0001
ln PFOA	0.091	0.032	2.83	0.006

*natural log

000121

Figure 4. Linear Regression of Triglycerides* by PFOA* for Cottage Grove Male Employees, 2000 Medical Surveillance Program



Summary of Fit

RSquare	0.008

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio
Model	1	0.452	0.452	1.076
Error	129	54.251	0.421	Prob>F
C Total	130	54.704		0.302

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	5.022	0.057	88.04	<.0001
ln PFOA	0.032	0.031	1.04	0.302

*natural log