STUDY SUMMARY OF ENVIRONMENTAL EFFECTS OF LIGHT WATER BRAND AFFF AND COMPONENTS - 1991

TEST SUBSTANCE

Identity: A mixture containing perfluorooctanesulfonate, which may also be referred to as PFOS, FC-95, or as a component of FC-203. (1-Octanesulfonic acid) (CAS # 2795-39-3).

Remarks: The 3M production lot number was not noted. The test sample is FC-203. Current information indicates it is a mixture of 1.34% PFOS, 35% diethylene glycol butyl ether, 37.85% water, 20% ethylene glycol, 2.66 % Sultone foamer, 3% sodium octyl sulfate, 0.1% sodium lauryl sulfate, and 0.05% tolyltriazole.

The following summary applies to a mixture with incompletely characterized concentrations of impurities. Data may not accurately reflect toxicity or degradation of the fluorochemical component of the test sample.

RESULTS

Degradability

Study	Value (source*)
BOD_5	560 g/L (3M)
	717 g/L (German Army Report)
BOD_{20}	1,060 g/L (3M)
COD	1,070 g/L (3M)
	1,373 g/L (German Army Report)
BOD_5/COD	0.52 (3M and German Army Report

Aquatic toxicity

Study	Value (source*)
Microtox	
EC_{10}	632 mg/L (German Army Report)
EC_{50}	2,500 mg/L (German Army Report)
Activated Sludge Inhibition	None at 1,000 mg/L (3M)
Algae (*Chlorella pyrenoidosa* and *Phormidium inundatum*)	No effect at ≤1,000 mg/L (3M)
Algae (*Scenedesmus subspicatus*)	
72-hr Static Popul. Growth Inhib. EC_{10}	16.9 mg/L (German Army Report)
72-hr Static Popul. Growth Inhib. EC_{50}	160 mg/L (German Army Report)
Water Flea (*Daphnia magna*)	

24-hr Static EC_{10}	31.6 mg/L (German Army Report)
24-hr Static EC_{50}	430 mg/L (German Army Report)
48-hr Static EC_{50}	229 mg/L (3M)
48-hr Static EC_{50}	1,600 mg/L (3M)
Eastern Oyster Embryo-larvae (*Crassostrea Virginica*)	
48-hr Static EC_{50}	47 mg/L (3M)
Grass Shrimp (*Palaemonetes pugio*)	
96-hr Static LC_{50}	510 mg/L (3M)
Fathead minnow (*Pimephales promelas*)	
96-hr Static LC_{50}	750 mg/L (3M)
Zebrafish (*Brachydanio rerio*)	
48-hr Static LC_0	1,053 mg/L (German Army Report)
48-hr Static LC_{50}	1,634 mg/L (German Army Report)
Scud (*Gammarus fasciatus*)	
48-hr Static LC_{50}	1,100 mg/L (3M)
Rainbow trout (*Oncorhyncus mykiss*)	
96-hr Static LC_{50}	1,300 mg/L (3M)
96-hr Continuous Flow LC_{50}	400 mg/L (3M)
Common mummichog (*Fundulus heteroclitus*)	
96-hr Static LC_{50}	2,500 mg/L (3M)

* Any study marked with "3M" as the source includes studies done at the request of 3M by labs other than the 3M Environmental Lab.

DATA QUALITY

Reliability: These studies have been assigned Klimish rankings = 4. Values are from a summary list only.

OTHER

Submitter: 3M Company, Environmental Laboratory, P.O. Box 33331, St. Paul, Minnesota, 55133

Last changed: 6/27/00

Technical Report Summary

Form 6747 - 11 - H

To: Patent & Technical Communications Services — 201-2C-12

Report Summary must be typewritten. Guidelines are on reverse side. If report is printed on both sides of paper, send two copies to P & TCS.

Document Number:	Department Number: 0222	Project Number:	Report Number: (Place additional D.N.s in Abstract area)
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Keywords

LIGHT WATER, aqueous foam, FC-203, FC-206, ethylene glycol, butyl Carbitol, sodium laurylsulfate, Duponol, sodium dodecylsulfate, sodium octylsulfate, L-4640, triethanolamine, urea, Triton X-305, foamer, filmer, surfactant, tolyltriazole, environmental effects, toxicity, Daphnia toxicity, Microtox, algal toxicity, fish toxicity, degradability, biochemical oxygen demand, BOD, chemical oxygen demand, COD.

Project Objective & Report Abstract

1. To add to the knowledge base of environmental effects of LIGHT WATER brand aqueous film forming foams and the components used in the products. 2. To identify toxic components and to correlate component and product toxicities.

This technical report includes a summary of environmental effects data on 3M's products and the components used in them. The data was taken from the literature and from previous studies by the 3M Environmental Laboratory. The data for each component and each product have been evaluated for completeness and accuracy and additional testing requirements have been noted. Where sufficient data on the toxicity and degradability of individual components were available, the data were evaluated and recommendations regarding inclusion of the component in future products have been made.

An attempt was made to correlate the toxicity of FC-203 to the toxicity of its components by taking into consideration the component concentration in the product. While product toxicity could not be conclusively correlated to the toxicity and concentration of individual components, major contributors to product toxicity are believed to be the filmer, the foamer, butyl Carbitol™, and Duponol™ ME (sodium laurylsulfate). Components likely to contribute less to product toxicity are ethylene glycol, tolyltriazole, sodium octylsulfate, and DI-water. Further toxicity testing of components and product formulations should enable better correlation between component and product toxicities.

Report Type	☒ R & D Research and Development	☐ TRP Trip or Field Report	☐ TECh. Service
	☐ PILot Plant	☐ FACtory Experiment	☐ GOVt. Project
	☐ MANufacturing	☐ ENGineering	☐ OTHER
	☐ Management SUMmary	☐ ROI Record of Invention	
Security	☒ Open Report and Summary	☐ Closed Report - Open Summary	**3M Chemical Registry** ☐ New Chemicals Reported (Use form 6092 to enter into Chemical Registry)
Notebook Reference			For P & TCS Use Only ► Film Code: [illegible] Number of Pages: [illegible]
Information Liaison Initials			P & TCS Editor Initials

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Contents

Environmental Effects of LIGHT WATER™ Aqueous Film Forming Foam and Components

1. Purpose

The purpose of this study is to increase 3M's knowledge of the environmental effects of LIGHT WATER™ aqueous film forming foam and the individual components used to make the product. And, by understanding these effects, to minimize them through formulation changes.

II. Background

This study was undertaken in response to testing done by the German Army which was reported in "Investigations of Toxic Effects and Biological Degradability of Foam Extinguishing Agents in Wastewater" by Ekkehard Ising. The report, hereafter referred to as the "German Army Report", included data for 16 fire fighting materials, of which two were 3M's FC-203 and FC-206. The 16 fire extinguishing agents were categorized as:

- 5 multi-range foam agents
- 6 film-forming foam agents
- 3 protein foam agents
- 1 film-forming fluorine-protein foam agent
- 1 special foam agent for deep-fry pan fires

Environmental effects considered in the German Army Report were:

1. Acute toxicity to the marine photoluminescent bacterium *Photobacterium phosphoreum* using the Microtox® system. The toxicity was expressed as EC_{10} and EC_{50}, however, the exposure time is not clear from the German Army Report and may have been 10, 20, or 30 minutes. Two multi-range foam agents were considered "highly toxic". Three multi-range foam agents and 2 film forming agents were found to be "toxic". Four film-forming, all 3 protein, the film-forming fluorine-protein agent, and the deep-fry agent were considered to have "low toxicity". FC-203 and FC-206 were in the "low toxicity" category.
2. Algae cell multiplication inhibition test using *Scenedesmus subspicatus* as the test organism with an exposure time of 72 hours. Toxicity was expressed as EC_{10} and EC_{50}. All foam agents with the exception of two of the protein foam agents were "toxic" to algae. The two protein foam agents had weak toxicity to algae. Both 3M products were considered "toxic" to algae.
3. Acute toxicity to *Daphnia magna* after exposure for 24 hours. The toxicity was expressed as LC_{10} and LC_{50}, but the effect criterion was the organisms' loss of ability to swim and will be referred to as EC_{10} and EC_{50} in this report. All 5 multi-range foam agents, all film-forming agents except FC-206, and the deep-fry agent were "toxic" to

Daphnia. One film-forming agent (FC-206), all three protein agents, and the film-forming fluorine-protein agent had "low toxicity" to *Daphnia*. FC-203: "toxic"; FC-206: "low toxicity".

4. Acute toxicity to Zebrafish (*Brachydanio rerio*) after exposure for 48 hours. The criteria was death and the toxicity was expressed as LC_{10} and LC_{50}. Only two multi-range foam agents were "toxic" to fish. Three multi-range foam agents and two film-forming agents were "borderline toxic/weakly toxic". "Weakly toxic" were 4 film-forming agents, 2 protein foam agents, and the deep-fry agent. One film-forming agent and the film-forming fluorine-protein agent were "non-toxic". FC-203 and FC-206 were in the "weakly toxic" category.
5. Chemical Oxygen Demand (COD) and 5-day Biochemical Oxygen Demand (BOD_5) of a 3% solution of the test material in water. The ratio of BOD_5 to COD was used as a rating guideline, with a BOD_5/COD ratio of 0.5 or less considered "insufficient biochemical degradation". Two multi-range agents and one film-forming agent (FC-206) were considered insufficiently degraded biochemically. The ratio for FC-206 was 0.35. One multi-range agent and one film forming agent (FC-203) were considered "probably insufficient" because their BOD_5/COD ratios were 0.55. The 9 remaining agents were all sufficient with their BOD_5/COD ratios ranging from 0.60 to 0.89.

The data from the German Army Report for the two 3M products are summarized in the table below. The data for the Microtox, Zebrafish, COD, and BOD_5 tests seem to be "reasonable" and "self-consistent". The data are considered reasonable because they agree fairly well with data from previous 3M studies and are considered self-consistent because the FC-206 data are roughly half that of FC-203.

Summary of German Army Report Data

Product	Microtox EC_{10}	Microtox EC_{50}	Algae EC_{10}	Algae EC_{50}	*Daphnia* LC_{10}	*Daphnia* LC_{50}	Zebrafish LC_{10}	Zebrafish LC_{50}	COD	BOD_5	BOD_5/COD Ratio
FC-203	632	2,500	16.9	160	31.6	430	1,053	1,634	41,200	21,500	0.52
	"Low Toxicity"		"Toxic"		"Toxic"		"Weakly Toxic"		—	—	"Probably Insufficient"
FC-206	2,040	15,000	16.3	160	305	2,000	2,036	4,086	24,600	8,700	0.35
	"Low Toxicity		"Toxic"		"Low Toxicity"		"Weakly Toxic"		—	—	"Insufficient"

Note: all concentrations in mg/L.

For the algal toxicity data, there are two important points to consider. First, the German Army's algae data show essentially equivalent toxicity for our two products. One would expect more toxicity for FC-203 than for FC-206, as shown in the Microtox, Zebrafish, and *Daphnia* tests. However, higher toxicity by FC-203 than by FC-206 may not always be true. For example, there may be a component which is particularly toxic to algae, perhaps disrupting the photosynthetic process. Second, our PED for FC-203 indicates no effect to two algal species at concentrations up to 1,000 mg/L. While the two algal species on the PED are not the same as those in the German Army Report, they are all freshwater species and such a large difference in toxicity wouldn't be expected. One important limitation with the PED data is that it dates from 1974 and it has been impossible to verify the exact formulation of the sample used in those tests.

For the *Daphnia* data in the German Army Report, the difference between the FC-206 and FC-203 values seems large when considering the water content of the two formulations. Also, there is a considerable difference between the PED data and the German Army data. Our PED has a 48-hr static *Daphnia magna* LC_{50} of 1,600 mg/L, while the German Army Report has a 24-hr static *Daphnia magna* EC_{50} is 430 mg/L. The PED data is quite old (1973) and the formulation of the test sample cannot be verified. There is a major difference between the PED data and the German Army data in that the PED data is the concentration which causes death to 50% of the *Daphnia* test population (LC_{50}) and the German Army value is the concentration which causes 50% of the test population to stop swimming (Effective Concentration = EC_{50}). The German Army value is in fair agreement with recent results [1] which show a 48-hr static *Daphnia magna* EC_{50} of 229 mg/L.

One thing that should be kept in mind when considering the toxicity data is that reproducibility and precision of toxicity tests can vary considerably from laboratory to laboratory and over time. However, the differences between the old data (circa 1974) and the more recent data is more likely due to changes in formulation rather than changes in test protocol or test species. At any rate, our primary interest should be the toxicity of our current products and we should be concerned with having current, reliable data on our PEDs.

III. General Comments

The following general statements summarize the factors guiding this study.

1. The primary purpose of the environmental effects data is for internal use in evaluating formulations and ingredients and not intended for submission to governmental regulatory authorities. Therefore, any testing should be done using low-cost, non-GLP methods. An exception may be data for the new foamer (L-4640) which may need to be submitted for the European PMN currently underway.

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1 Draft Report from EnviroSystems Laboratory dated March 10, 1991. We have asked EnviroSystems to repeat the *Daphnia* tests for FC-203 and VW160390. The preliminary results from EnviroSystems on the rest of the samples were acceptable.

2. The German Army performs its own testing and no authority other than the German Army is presently using the evaluation scheme used in the report cited above. Therefore, there is no need to choose a laboratory, test protocol, or test species applicable only to the German Army test scheme. Instead, test methods and species should be chosen so that test results can be used in as many countries as possible.
3. Where possible, data on the environmental effects of components should be obtained from the literature or from raw material suppliers in order to reduce testing costs and time.
4. The National Institute of Occupational Safety and Health (NIOSH) terminology for the relative toxicity of the components and the formulations will be used in the discussion of toxic effects. While these terms were not used in the German Army Report, they are generally accepted in the US. The toxicity and corresponding terms are:

Concentration Acutely Toxic to Test Population	NIOSH Terminology
≤1 mg/L	"Highly Toxic"
1 - 10 mg/L	"Moderately Toxic"
10 - 100 mg/L	"Slightly Toxic"
100 - 1,000 mg/L	"Practically Non-Toxic"
>1,000 mg/L	"Insignificant Toxicity"

5. The LIGHT WATER AFFF formulations and components considered are:
    1. Ethylene Glycol (RM 3017)
    2. Butyl Carbitol® (RM 8887)
    3. Duponol® ME (RM 3021)
    4. Tolyltriazole (RM 27513)
    5. Foamer (FM-4115)
    6. Filmer (FM-3820 = FC-95)
    7. Na-octylsulfate (RM 32067 or RM 55040)
    8. DI-water (RD 199)
    9. FC-203
    10. VW160390 (FC-203 without Tolyltriazole RM 27513)
    11. FC-203CE (same as FC-203C)
    12. FC-206CE
    13. FC-203CF
    14. FC-206CF

15. L-4640
16. Witcolate 7093 (RM 45666)
17. Triethanolamine
18. Urea
19. Triton X-305

Items 1 to 10 are from a list given to Eric Reiner by Wim Vanneste 3/12/90. Items 11 to 13 were given to the author by Wim Vanneste 2/5/91. Items 14 to 16 were given to the author by Roger Alm (2/4/91).

IV. Conclusions and Recommendations

In order to correlate the toxicity of the product to the toxicity of individual components, the component concentration is taken into consideration. In the table below, the toxicity to *Daphnia* of the pure components are given in the third column. The fifth column contains estimated toxicities based on product formulation. This is the toxicity which would be expected when the component is diluted in water to the same concentration as in the product. For example, one would expect that since the toxicity of pure butyl Carbitol ® is about 700 mg/L, the toxicity of a solution made of 35% butyl Carbitol ® and 65% water would have a toxicity of about 2,000.

Some interesting observations can be made from these numbers. First, even though tolyltriazole is quite toxic, it is present at low concentration in the product and when diluted in the product it probably does not contribute substantially to product toxicity. However, this analysis does not exonerate tolyltriazole as a major contributor to product toxicity. Second, the lowest numbers in the fifth column indicate components which will be the most likely contributors to product toxicity: butyl Carbitol®, Duponol® ME (dodecylsulfate), the foamer, and the filmer. Unfortunately, there is not a single component which stands out with a number in the fifth column which is substantially lower than all the rest. This may mean that there is a synergistic effect between components.

Summary of Recent *Daphnia* Toxicity Data

Item	Name	*Daphnia* Toxicity[2] (mg/L) (95% confidence interval)	FC-203 Formulation	Component Toxicity Based on Formulation	Major Contributor to FC-203 Toxicity?
1.	Ethylene glycol (RM 3017)	>1,000	20.00%	>5,000	Probably not
2.	Butyl Carbitol® (RM 8887)	706 (523 -1,000)	35.00%	2,017	Probably
3.	Duponol® ME (RM 3021)	2.9 (2.3 - 3.5)	0.10%	2,900	Probably
4.	Tolyltriazole (RM 27513)	19 (12 - 25)	0.05%	38,000	Probably not
5.	Foamer (FM-4115)	68 (50 - 81)	2.66%	2,556	Probably
6.	Filmer (FM-3820 = FC-95)	49 (43 - 56)	1.34%	3,657	Probably
7.	Na-octylsulfate (RM 32067 or RM 55040)	517 (400 - 1,000)	3.00%	17,233	Probably not
8.	DI-water (RD 199)	>1,000	37.85%	>2,642	No
9.	FC-203	229 (150 - 444)			X
10.	VW160390 (FC-203 without Tolyltriazole)	165 (128 - 248)			X

The important conclusion from these *Daphnia* results is that a more complete set of toxicity data is needed, especially for algae. The table below summarizes the additional data needed to complete the environmental effects database on our products and their ingredients. Additional tests are indicated with an X.

2 Preliminary results from EnviroSystems, March 10, 1991.

Summary of Additional Testing

Item	Name	Microtox	Algae	*Daphnia*	Fish	COD	BOD
1.	Ethylene glycol (RM 3017)						
2.	Butyl Carbitol® (RM 8887)	X	X				
3.	Duponol® ME (RM 3021)	X	X			X	X
4.	Tolyltriazole (RM 27513)	X	X			X	X
5.	Foamer (FM-4115)	X	X		X	X	X
6.	Filmer (FM-3820 = FC-95)	X	X				
7.	Na-octylsulfate (RM 32067 or RM 55040)	X	X		X	X	X
8.	DI-water (RD 199)						
9.	FC-203		X				X
10.	VW160390 (FC-203 without Tolyltriazole)	X	X		X		X
11.	FC-203CE (same as FC-203C)		X	X			
12.	FC-206CE		X	X			
13.	FC-203CF	X	X	X	X	X	X
14.	FC-206CF	X	X	X	X	X	X
15.	L-4640	X	X				
16.	Witcolate 7093 (RM 45666)	X	X	X	X	X	X
17.	Triethanolamine						
18.	Urea						
19.	Triton X-305	X	X	X	X	X	X
	TOTAL	12	15	6	7	8	10

Note: BOD testing will include 5-, 10-, and 20-day tests.

V. Environmental Effects Literature Search

Data from previous 3M Environmental Laboratory Studies and from the literature are summarized in this section. Toxicity data noted by "AQUIRE" were obtained from a search of the USEPA AQUIRE database on Feb. 12, 1991. Included as part of the reference for the data from AQUIRE are the date of publication of the original journal article and the review code established by a group of EPA reviewers. The reviewers have ranked toxicity data from the literature by the following scale:

1. Meets all review criteria.
2. Procedures generally satisfactory.
3. Insufficient in some area of the test methodology or test report.
4. Abstract or foreign paper with data in limited format.

The complete contents of the AQUIRE database for each chemical is not given in this report because the database includes many obscure species of little interest (opossum shrimp, Indian catfish, snakehead catfish, oysters, clams, sponges and many others) and data which is considered by the EPA reviewers to be of questionable value.

Additional degradability and toxicity data have been taken from the *Handbook of Environmental Data on Organic Chemicals* by Karel Verschueren (Nostrand Reinhold, New York, 1983). These are referenced by page number in the Handbook followed by the date of the original reference. There are many cases in which the same data appeared on AQUIRE and in Verschueren but only the AQUIRE reference is given because it includes the EPA quality rating of the original reference.

Raw material suppliers were identified from the 3M PRISM database and suppliers were contacted and asked for any environmental data they have. Unfortunately, environmental data was not generally available from raw material suppliers. And, the suppliers were slow in sending the limited data do have.

The source and reliability of the literature data was taken into consideration in the environmental assessment of the components and the recommendations for further testing.

Report Format:
Information for each component or formulation is organized as follows:

Formulation or component name and RM number
Chemical Abstracts Service (CAS) Number
Vendors
Degradability data from the literature or from previous 3M assessments
Aquatic Toxicity data from the literature or from previous 3M assessments
Environmental Assessment
Recommendations for Additional Testing

Detailed information for components and formulations are given in the same order as in the list above.

1. Ethylene Glycol (RM 3017)

CAS # 107-21-1

Vendors: Chemtech, Ashland Chemical, Dow Chemical, Texaco Chemical, Olin, Shell Oil, Union Carbide, Textile Chemical, Ashland Chemical, Unocal

Degradability:

Theoretical Oxygen Demand (ThOD)	1.29 g/g (Verschueren p 646)
BOD_5	0.44±0.22 g/g (avg of 12 citations from Verschueren p 646) 0.52 g/g (Env. Lab.[3] Req. #1940)
BOD_{10}	0.67 g/g (Verschueren p 646; 1953) 1.19 g/g (Env. Lab. Req. #1940)
BOD_{15}	0.92 g/g (Verschueren p 646; 1953) 1.14 g/g (Env. Lab. Req. #1940)
BOD_{20}	1.00±0.08 g/g (avg of 3 citations from Verschueren p 646) 1.02 g/g (Env. Lab. Req. #1940)
COD	1.24±0.04 g/g (avg of 3 citations from Verschueren p 646) 1.28 g/g (Env. Lab Req. #1940)
BOD_5/COD Ratio	0.4 (Env. Lab Req. #1940)
BOD_{20}/COD Ratio	0.8 (Env. Lab Req. #1940)

Toxicity:[4]

Green Algae (*Scenedesmus quadricauda*)	
7-day Static Popul. Growth Inhib.[5]	10,000 mg/L (AQUIRE 2; 1980)
8-day static Popul. Growth Inhib.	10,000 mg/L (AQUIRE 2; 1978)

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3 3M Environmental Lab work done in Dec. 1973.

4 The toxicity data are a partial listing of 38 tests on 16 species from the EPA AQUIRE database.

5 Population Growth Inhibition: Change in cell number of algal species including pre-exponential lag rate effects.

Protozoa (*Entosiphon sulcatum*)	
72-hr Static Popul. Growth Inhib.	10,000 mg/L (AQUIRE 2; 1980)
Blue-green Algae (*Anacystis aeruginosa*)	
8-day Static Popul. Growth Inhib.	2,000 mg/L (AQUIRE 2; 1978)
Bacteria (*Pseudomonas putida*)	>10,000 mg/L (Verschueren p 647)
Algae (*Microcystis aeruginosa*)	2,000 mg/L (Verschueren p 647)
Protozoa (*Uronema parduczi*)	>10,000 mg/L (Verschueren p 647)
Water flea (*Daphnia magna*)	
48-hr Static EC_{50}	>1,000 mg/L (EnviroSystems 1991)[6]
24-hr Static LC_{50}	10,000 mg/L (AQUIRE 2; 1977)
24-hr Static LC_{50}	10,000 mg/L (AQUIRE 3; 1983)
48-hr Static LC_{50}	10,000 mg/L (AQUIRE 3; 1983)
Brine shrimp (*Artemia salina*)	
24-hr Static LC_{50}	20,000 mg/L (AQUIRE 2; 1974)
24-hr Static LC_{50}	20,000 mg/L (AQUIRE 3; 1983)
Fathead Minnow (*Pimephales promelas*)	
24-hr Static LC_{50}	10,000 mg/L (AQUIRE 3; 1983)
48-hr Static LC_{50}	10,000 mg/L (AQUIRE 3; 1983)
96-hr Static LC_{50}	10,000 mg/L (AQUIRE 3; 1983)
96-hr Static LC_{50}	49,000 mg/L, 53,000 mg/L, & 57,000 mg/L (AQUIRE 2; 1983)
Bluegill Sunfish (*Lepomis macrochirus*)	
96-hr Static LC_0	10,000 mg/L (AQUIRE 2; 1968)
Rainbow Trout (*Salmo gairdneri*)	
96-hr Static LC_{50}	41,000 mg/L (AQUIRE 2; 1980)
Common Shrimp (*Crangon crangon*)	
48-hr Renewal LC_{50}	100,000 mg/L (AQUIRE 2; 1974)
96-hr Renewal LC_{50}	50,000 mg/L (AQUIRE 2; 1974)
Goldfish (*Carassius auratus*)	
96-hr Static LC_{50}	5,000 mg/L (AQUIRE 2; 1979)
Guppy (*Poecilia reticulata*)	
7-day Renewal LC_{50}	49,300 mg/L (AQUIRE 3; 1981)

6 Acute Daphnid toxicity testing done by EnviroSystems for 3M. Test results dated March 10, 1991.

Environmental Assessment:
Ethylene glycol has insignificant toxicity and a high BOD/COD ratio. Even though it is present in high concentration in the product, it probably does not contribute substantially to product toxicity.

Recommendations for Additional Testing:
None.

2. Butyl Carbitol® (RM 8887)

CAS # 112-34-5 (Diethylene Glycol Monobutyl Ether)

Synonyms and vendors: Butyl Dioxitol (Cain Chemical), Poly-Solv DB (Olin Corporation), Glycol Ether DB (Oxychem), Butyl Carbitol® (Union Carbide Corporation - Linde Div.), Butyl Dioxitol (Shell Oil Company), Dowanol DB (Dow Chemical), Ektasolve-DB (Eastman Chemical Products, Inc.)

Degradability:

ThOD	2.17 g/g (calculated)
BOD_5	0.25 (Verschueren p 524) 0.69 g/g (Env. Lab.[7] Req. #1940)
BOD_{10}	1.45 g/g (Env. Lab. Req. #1940)
BOD_{15}	1.61 g/g (Env. Lab. Req. #1940)
BOD_{20}	1.56 g/g (Env. Lab. Req. #1940)
COD	2.08 (Verschueren p 524) 1.83 g/g (Env. Lab. Req. #1940)
BOD_5/COD Ratio	0.12 (Verschueren p 524) 0.37 (Env. Lab. Req. #1940)
BOD_{20}/COD Ratio	0.85 (Env. Lab. Req. #1940)

Toxicity:[8]

Bacteria (*Pseudomonas putida*)	255 mg/L (Verschueren p 524)

7 3M Environmental Lab work done in Dec. 1973.
8 The toxicity data are a partial listing of 15 tests on 10 species from the EPA AQUIRE database.

Green Algae (*Scenedesmus quadricauda*)	
7-day Static Popul. Growth Inhib.	1,000 mg/L (AQUIRE 2; 1980)
8-day Static Popul. Growth Inhib.	1,000 mg/L (AQUIRE 2; 1978)
Blue-green Algae (*Anacystis aeruginosa*)	
8-day Static Popul. Growth Inhib.	53 mg/L (AQUIRE 2; 1978)
Protozoa (*Entosiphon sulcatum*)	
72-hr Static Popul. Growth Inhib.	73 mg/L (AQUIRE 2; 1980)
Protozoa (*Uronema parduczi*)	420 mg/L (Verschueren p 524)
Protozoa (*Chilomonas paramecium*)	
48-hr Popul. Growth Inhib.	2,774 mg/L (AQUIRE 4; 1980)
Water Flea (*Daphnia magna*)	
48-hr Static EC_{50}	706 mg/L (EnviroSystems 1991)
24-hr Static LC_{50}	2,850 mg/L (AQUIRE 2; 1977)
Bluegill Sunfish (*Lepomis macrochirus*)	
96-hr Static LC_{50}	1,300 mg/L (AQUIRE 2; 1977)
Goldfish (*Carassius auratus*)	
24-hr Static LC_{50}	2,700 mg/L (AQUIRE 2; 1979)
Guppy (*Poecilia reticulata*)	
7-day Renewal LC_{50}	1,150 mg/L (AQUIRE 3; 1981)
Silver ide (*Leuciscus idus*)	1,805 mg/L and 2,304 mg/L
Static LC_{50}	(AQUIRE 3; 1978)
Inland Silverside (*Menidia beryllina*)	
96-hr Static LC_{50}	2,000 mg/L (AQUIRE 2; 1977)

Environmental Assessment:

BOD data shows fairly high degradability. The literature data show this material to have insignificant toxicity to fish and *Daphnia*. The two freshwater green algae values from AQUIRE are consistent and indicate that butyl Carbitol ® is practically non-toxic to green algae. There is considerably more toxicity shown to blue-green algae, however. We should have a sample of butyl Carbitol ® tested for algal toxicity to be sure of its toxic effects.

Recommendations for Additional Testing:

Algae and Microtox.

3. Duponol® ME Dry Surfactant (RM 3021; Sodium Lauryl Sulfate)

CAS # 151-21-3 (Sodium Dodecylsulfate $CH_3(CH_2)_{11}OSO_3Na$)

Vendor: Dupont[9]

Degradability:

ThOD	2.03 g/g (calculated)
BOD	Swisher[10] reports that "linear primary alkyl sulfates have long been recognized as extremely rapid in primary biodegradation, often disappearing in less than a day" and cites approximately 100 references which show degradation rates of 80 to 100% within a few hours or days.

Toxicity:[11]

Green Algae (*Chlorella* sp)	
Static Popul. Growth Inhib.	50 mg/L (AQUIRE 4; 1980)
Green Algae (*Chlorella vulgaris*)	
72-hr Static Growth Inhibition[12]	0.05 mg/L (AQUIRE 4)
Green Algae (*Scenedesmus quadricauda*)	
7-day Static Popul. Growth Inhib.	0.02 mg/L (AQUIRE 2; 1980)
8-day Renewal Growth Inhibition	0.02 mg/L (AQUIRE 2; 1978)
Flagellate Euglenoid (*Entosiphon sulcatum*)	
72-hr Static Popul. Growth Inhib.	40 mg/L (AQUIRE 2;)
Blue-green Algae (*Anacystis aeruginosa*)	
8-day Renewal Popul. Growth Inhib.	7 mg/L (AQUIRE 2; 1978)
Bacteria (*Pseudomonas putida*)	
Cell Multiplication Inhibition	290 mg/L (Verschueren p 793; 1980)
Protozoa (*Uronema parduczi*)	
Cell Multiplication Inhibition	0.75 mg/L (Verschueren p 793; 1980)

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9 Phone: 302-774-1000. 2/15/91: will send information.

10 Swisher, R. D. Surfactant Biodegradation, 2nd ed. Marcel Dekker: New York, 1987, p 466, 807-811.

11 The toxicity data are a partial listing of the 409 tests on 49 species from in the EPA AQUIRE database.

12 Growth Inhibition: Measurable change in length and/or weight.

Water flea (*Daphnia magna*)	
48-hr Static EC_{50}	2.9 mg/L (EnviroSystems 1991)
24-hr Static LC_{50}	33.0 mg/L (AQUIRE 2; 1977)
24-hr Static LC_{50}	7.2, 10.0, & 12.0 (AQUIRE 3; 1983)
48-hr Static LC_{50}	7.0±2.1 mg/L (avg of 8; AQUIRE 2; 1982)
48-hr Static LC_{50}	5.0±0.5 mg/L (avg of 3; AQUIRE 3; 1983)
48-hr Flow-through LC_{50}	1.8 mg/L (AQUIRE 2; 1981)
Fathead Minnow (*Pimephales promelas*)	
24-hr Static LC_{50}	7.4 & 8.5 mg/L (AQUIRE 3; 1983)
48-hr Static LC_{50}	6.6 & 7.3 mg/L (AQUIRE 3; 1983)
96-hr Static LC_{50}	6.6 & 6.9 mg/L (AQUIRE 3; 1983)
Bluegill (*Lepomis macrochirus*)	
96-hr Flow-through LC_{50}	4.5 mg/L (AQUIRE 2; 1981)
Mummichog (*Fundulus heteroclitus*)	
96-hr Static LC_{50}	2.1 mg/L (AQUIRE 2)
Sheepshead Minnow (*Cyprinodon variegatus*)	
24-hr Static LC_{50}	10.0 mg/L (AQUIRE 2)
48-hr Static LC_{50}	9.0 mg/L (AQUIRE 2)
96-hr Static LC_{50}	9.0 mg/L (AQUIRE 2)
High-eyes Medaka (*Oryzias latipes*)	
6-hr Renewal LC_{50}	67 mg/L (AQUIRE 2)
24-hr Renewal LC_{50}	46 mg/L (AQUIRE 2)
48-hr Renewal LC_{50}	46 mg/L (AQUIRE 2)
Brine Shrimp (*Artemia salina*)	
24-hr Static LC_{50}	3.6 mg/L (AQUIRE 2; 1974)
Atlantic Silverside (*Menidia menidia*)	
96-hr Static LC_{50}	2.8 mg/L (AQUIRE 2; 1982)
Killifish (*Fundulus similis*)	
24-hr Static LC_{50}	4.7 mg/L (AQUIRE 2)
48-hr Static LC_{50}	4.7 mg/L (AQUIRE 2)
96-hr Static LC_{50}	4.5 mg/L (AQUIRE 2)
Rainbow Trout (*Salmo gairdneri*)	
48-hr Flow-through LC_{50}	5.95 mg/L (Verschueren p 793; 1977)
96-hr Flow-through LC_{50}	4.62 mg/L (Verschueren p 793; 1977)
10-day Flow-through LC_{50}	2.85 mg/L (Verschueren p 793; 1977)

Zebrafish (*Brachydanio rerio*)

48-hr Flow-through LC_{50}	8.81 mg/L (Verschueren p 793; 1977)
96-hr Flow-through LC_{50}	7.97 mg/L (Verschueren p 793; 1977)
10-day Flow-through LC_{50}	7.97 mg/L (Verschueren p 793; 1977)

Flagfish (*Gordanella floridae*)

48-hr Flow-through LC_{50}	10.0 mg/L (Verschueren p 793; 1977)
96-hr Flow-through LC_{50}	8.10 mg/L (Verschueren p 793; 1977)
10-day Flow-through LC_{50}	6.90 mg/L (Verschueren p 793; 1977)

Environmental Assessment:
Literature data indicates fairly low toxicity to bacteria and although no actual BOD test data are available, this material should be readily degraded by microorganisms. A BOD value should be obtained by our own BOD tests.

This material is moderately toxic to fish, *Daphnia*, and algae. Our most recent *Daphnia* test data agrees well with literature data which gives us confidence in the contract laboratory's work on this material. Because there is sufficient fish toxicity data from the literature, no fish testing is warranted.

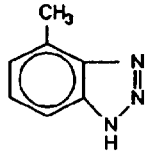
Because of the algal toxicity shown in the literature data, algae testing should be done.

Even though this material is toxic to a variety of aquatic organisms, it readily degrades and adverse effects will be minimal if it is passed through a wastewater treatment system or if a significant number of microorganisms are present in a natural water to degrade it rapidly. We should do some studies in which our product is passes through a model wastewater treatment system and the measure the toxic effects of the model's effluent. Another study would be a simulation of a natural body of water using an aquarium stocked with fish. This would give us an understanding of the degradation in a river, pond, or lake.

Recommendations for Additional Testing:
BOD, COD, and Microtox.

4. Tolyltriazole (RM 27513; Corrosion Inhibitor Tolyltriazole Technical Grade)

CAS # 29385-43-1
$C_7H_7N_3$



Synonyms and vendors:
Methyl-1H-Benzotriazole

Methylbenzotriazole
Cobratec TT-100 (PMC, Inc.[13])
Preventol CI7-100 (Mobay Corp.[14])

Degradability:

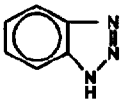
BOD	<60% ThOD (Mobay Corp.)

Toxicity:

Water Flea (*Daphnia magna*)	
48-hr Static EC_{50}	19 mg/L (EnviroSystems 1991)
Bluegill Sunfish	
96-hr LC_{50}	31.0 mg/L (Mobay Corp. and PMC)
Rainbow Trout	
96-hr LC_{50}	21.4 mg/L (Mobay Corp. and PMC)
Fathead Minnow	
96-hr LC_{50}	25.5 mg/L (Mobay Corp. and PMC)

Additional data for a similar compound:

1H-Benzotriazole ($C_6H_6N_3$)



CAS Number: 95-14-7

Synonyms:
1,2,3-Benzotriazole
Aziminobenzene
Benzene Azimide
Benzotriazole

Bluegill sunfish (*Lepomis macrochirus*)	
Static 24-hr Stress	5 mg/L (AQUIRE 3; 1957)
Rainbow Trout (*Salmo gairdneri*)	
Static 24-hr Stress	5 mg/L (AQUIRE 3; 1957)
Sea Lamprey (*Petromyzon marinus*)	
Static 24-hr Stress	5 mg/L (AQUIRE 3; 1957)
Chinook Salmon (*Oncorhynchus tshawytscha*)	
Static 24-hr Mortality	10 mg/L (AQUIRE 3; 1969)

13 PMC Specialities Group, Inc. Technical Bulletin 3200. Contact: Bill Mautlewicz (513-242-3300).

14 Mobay Corp. data given by Matthew Bartman 412-777-2000.

Coho Salmon (*Oncorhynchus kisutch*)
Static 24-hr Mortality 10 mg/L (AQUIRE 3; 1969)

Northern Squawfish (*Ptychocheilus oregonensis*)
Static 24-hr Mortality 10 mg/L (AQUIRE 3; 1969)

Environmental Assessment:
While the limited data shows that this material is moderately toxic, it is present at such low concentration (0.05%) in the product, it may have little effect in the overall toxicity of the product. Because of the toxicity of this material, we need a complete set of data. There is no reason to repeat the fish data, however.

This material is listed on the TSCA 8(d) list and any testing done must be reported to the US EPA.

Recommendations for Additional Testing:
BOD, COD, algae, and Microtox.

5. Foamer (FM-4115)

Toxicity:

Water Flea (*Daphnia magna*)
48-hr Static EC_{50} 68 mg/L (EnviroSystems 1991)

Environmental Assessment:
The foamer shows slight toxicity to *Daphnia*, but there is no data for the remaining environmental effects. We should have a complete set of effects data for this material.

Care should be taken that the sample used in the environmental effects testing is a good representative sample which has been produced by the manufacturing method which will be used in the future.

Recommendations for Additional Testing:
BOD, COD, fish, algae, and Microtox.

6. Filmer (FM-3820 or FC-95)

Degradability:

BOD_5	nil (PED)
BOD_{10}	nil (PED)
BOD_{20}	nil (PED)
COD	nil (PED)
BOD/COD	0

Toxicity:

Water Flea (*Daphnia magna*)

48-hr Static EC_{50}	49 mg/L (EnviroSystems 1991)
48-hr Static EC_{50}	50 mg/L (PED)
Activated Sludge Inhibitory Conc.	>4,000 mg/L (PED)
Fathead Minnow (*Pimephales promelas*)	
96-hr LC_{50}	38 mg/L (PED)
Bluegill Sunfish (*Lepomis macrochirus*)	
96-hr LC_{50}	68 mg/L (PED)
Rainbow Trout (*Salmo gairdneri*)	
96-hr LC_{50}	11 mg/L (PED)

Environmental Assessment:
The filmer will not contribute to the BOD/COD ratio, so toxicity is the issue with this component. This material does show slight toxicity to fish and *Daphnia*. There is good agreement between previous and present *Daphnia* toxicity data which gives us confidence in the most recent data from EnviroSystems.

We need to have a complete set of effects data for a sample representative of a recent manufacturing lot which has been produced by the manufacturing method which will be used in the future.

Recommendations for Additional Testing:
Algae and Microtox.

7. Na-octylsulfate (RM 32067 or RM 55040[15])

CAS # 142-31-4

Vendors: Alcolac Incorporated[16] (Sodium Octyl Sulfate Solution); Stepan Company[17] (POLYSTEP B-29).

Degradability:

ThOD 1.88 g/g (calculated)

15 Wim Vanneste's PROFS note dated 03/12/1990 gives this RM#.
16 Alcolac: 301-355-2600. No data available.
17 Called 708-446-7500 ext. 2283: they have no data.

BOD Swisher[18] reports that "linear primary alkyl sulfates have long been recognized as extremely rapid in primary biodegradation, often disappearing in less than a day" and cites approximately 100 references which show degradation rates of 80 to 100% within a few hours or days.

Toxicity:[19]

Australian Barnacle (*Elminius modestus*)	
30-min Static Immobilization EC_{50}	3,970 mg/L (AQUIRE 2; 1976)
Water Flea (*Daphnia magna*)	
48-hr Static EC_{50}	517 mg/L (EnviroSystems 1991)

Environmental Assessment:
Although no BOD or COD data are available, this material will most likely have a high BOD/COD ratio. BOD and COD data should be obtained so that we have numerical values which have been obtained in tests comparable to those used for the remaining components.

There is surprisingly little literature data available on the aquatic toxicity of this surfactant, however for the *Daphnia* data it shows considerably less toxicity than the C_{12} surfactant. This surfactant is present at 3% so it may be a major factor to toxicity of the product. Fish, algae, and Microtox toxicity data are essential to complete the assessment of this ingredient.

Recommendations for Additional Testing:
BOD, COD, fish, algae, and Microtox.

8. DI-water (RD 199)

Toxicity:

Water Flea (*Daphnia magna*)	>1,000 mg/L (EnviroSystems 1991)
48-hr Static EC_{50}	

Environmental Assessment:
While it may seem foolish to test the deionized water for toxicity, toxic effects have been traced to contaminated deionized water supplies in the past. The *Daphnia* result indicates that the supply was not contaminated and no further testing of the deionized water sample is warranted.

Recommendations for Additional Testing:
None.

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18 Swisher, R. D. Surfactant Biodegradation. 2nd ed. Marcel Dekker: New York, 1987, p 466, 807-811.

19 There was 1 test given in the EPA AQUIRE database.

9. FC-203

Degradability:	
BOD_5	560 g/L (PED) 717 g/L (German Army Report[20])
BOD_{20}	1,060 g/L (PED)
COD	1,070 g/L (PED) 1,373 g/L (German Army Report)
BOD_5/COD	0.52 (PED and German Army Report)
Toxicity:	
Microtox	
EC_{10}	632 mg/L (German Army Report)
EC_{50}	2,500 mg/L (German Army Report)
Activated Sludge Inhibition	none at 1,000 mg/L (PED)
Algae (*Chlorella pyrenoidosa* and *Phormidium inundatum*)	no effect at ≤1,000 mg/L (PED[21])
Algae (*Scenedesmus subspicatus*)	
72-hr Static Popul. Growth Inhib. EC_{10}	16.9 mg/L (German Army Report)
72-hr Static Popul. Growth Inhib. EC_{50}	160 mg/L (German Army Report)
Water Flea (*Daphnia magna*)	
24-hr Static EC_{10}	31.6 mg/L (German Army Report)
24-hr Static EC_{50}	430 mg/L (German Army Report)
48-hr Static EC_{50}	229 mg/L (EnviroSystems 1991)[22]
48-hr Static EC_{50}	1,600 mg/L (PED[23])

20 "3% application solutions" were used to obtain the BOD_5 and COD data in the German Army Report. The German Army values were 41,200 mg/L and 21,500 mg/L for the COD and BOD_5, respectively. The German Army values were multiplied by 33.3 to get the values in this report.

21 Testing done by Industrial Bio-Test Laboratory, Jan. 1974.

22 EnviroSystems is repeating this test because there was not enough variation in the FC-203 concentrations they used to develop a good standard curve.

23 Testing done by Bionomics Laboratory, Dec. 1973.

Eastern Oyster Embryo-larvae (*Crassostrea virginica*) 48-hr Static EC_{50}	47 mg/L (PED[24])
Grass Shrimp (*Palaemonetes pugio*) 96-hr Static LC_{50}	510 mg/L (PED[25])
Fathead minnow (*Pimephales promelas*) 96-hr Static LC_{50}	750 mg/L (PED)
Zebrafish (*Brachydanio rerio*) 48-hr Static LC_0	1,053 mg/L (German Army Report)
48-hr Static LC_{50}	1,634 mg/L (German Army Report)
Scud (*Gammarus fasciatus*) 48-hr Static LC_{50}	1,100 mg/L (PED[26])
Rainbow trout (*Oncorhyncus mykiss*[27]) 96-hr Static LC_{50}	1,300 mg/L (PED)
Rainbow trout (*Oncorhyncus mykiss*) 96-hr Continuous Flow LC_{50}	400 mg/L (PED[28])
Common mummichog (*Fundulus heteroclitus*) 96-hr Static LC_{50}	2,500 mg/L (PED[29])
Grass Shrimp (*Palaemonetes pugio*) 96-hr LC_{50}	510 mg/L (PED)

Environmental Assessment:

1. The fish toxicity data from the German Army Report agrees well with data from previous 3M studies, so no fish testing is needed.

2. The Microtox tests from the German Army Report seem reasonable, so this test should not be repeated.

3. The 24-hr EC_{50} *Daphnia* toxicity from the most recent EnviroSystems work and the 48-hr EC_{50} from the German Army Report are in fairly good agreement. However, we weren't satisfied with the concentrations used in the EnviroSystems work and they are repeating

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24 Testing done by Bionomics Laboratory, July 1980.
25 Testing done by Bionomics Laboratory, Aug. 1979.
26 Testing done by Bionomics Laboratory, Dec. 1973.
27 Formerly *Salmo gairdneri*.
28 No mortality or abnormal effects at this concentration.
29 Testing done by Bionomics Laboratory, Aug. 1979.

this work. The large difference between German Army value and the 1973 PED value may be due to formulation changes or changes in the toxicity test protocol but this cannot be verified.

4. As with the foamer and filmer, we need to be careful that the sample submitted for testing is of known composition and from a known manufacturing lot.

5. Since toxicity to algae was of concern in the German Army Report, the algae data is probably the most important.

Recommendations for Additional Testing:
BOD, COD, and algae.

10. VW160390 (FC-203 without Tolyltriazole RM 27513)

Toxicity:

Water Flea (*Daphnia magna*)
48-hr Static EC_{50} 165 mg/L (EnviroSystems 1991)[30]

Environmental Assessment:

1. Since the only difference between this material and FC-203 is tolyltriazole, testing this material along with FC-203 seems like a good way to determine the effect of tolyltriazole. For the recent *Daphnia* data, there is little difference between FC-203 and VW160390 and the effect of tolyltriazole cannot be seen. In fact, the toxicity of FC-203 was slightly less than the toxicity of VW160390 in the recent EnviroSystems work. Since EnviroSystems is repeating the *Daphnia* for these two samples, we will have to wait until EnviroSystems has completed these tests before making an evaluation.

2. A Microtox and fish toxicity test should be done on this material and the results compared to the FC-203 results to see if there is a measurable effect caused by tolyltriazole in the product.

Recommendations for Additional Testing:
BOD, algae, fish, and Microtox.

30 EnviroSystems is repeating this test because there was not enough variation in the concentrations they used to develop a good standard curve.

11. FC-203CE

Degradability:

BOD_5	91 g/L (PED)
BOD_{10}	400 g/L (PED)
BOD_{20}	680 g/L (PED)
COD	762 g/L (PED)
BOD_{20}/COD ratio	0.89 (PED)
Total Organic Carbon (TOC)	220 g/L (PED)
OECD Method 301E	88-90% biodegradability in 14 days (PED)

Toxicity:

Algae (*Selenastrum capricornutum*) 95-hr IC_{50}	>1,000 mg/L (PED)
OECD Activated Sludge Respiration Inhibition Test 209	none at 1,000 mg/L
Water Flea (*Daphnia magna*) 48-hr Static LC_{50}	>1,000 mg/L (PED)
Microtox (*Photobacterium phosphoreum*)	
Exposure:	EC_{50}
5 min.	370 mg/L
15 min.	260 mg/L
30 min	230 mg/L
Killifish (*Fundulus heteroclitus*) 96-hr Continuous Flow LC_{50}	1,400 mg/L (PED)
Fathead Minnow (*Pimephales promelas*)	
96-hr Continuous Flow LC_{50}	>2,000 mg/L (PED)
96-hr Static LC_{50}	>1,000 mg/L (PED)

Environmental Assessment:

The environmental effects data for FC-203CE is fairly complete. The PED data shows lower toxicity to *Daphnia* than is shown by FC-203 in the German Army Report and from the recent tests by EnviroSystems. *Daphnia* testing should be done again for assurance in our PED.

Recommendations for Additional Testing:

Algae and *Daphnia*.

12. FC-206CE

Degradability:

BOD_5	46 g/L (PED)
BOD_{10}	260 g/L (PED)
BOD_{20}	470 g/L (PED)
COD	402 g/L (PED)
BOD_{20}/COD ratio	1.2 (PED)
Total Organic Carbon (TOC)	130 g/L (PED)
OECD Method 301E	89-92% biodegradability in 14 days (PED)

Toxicity:

Algae (*Selenastrum capricornutum*) 95-hr IC_{50}	>1,000 mg/L (PED)
OECD Activated Sludge Respiration Inhibition Test 209	none at 1,000 mg/L
Water Flea (*Daphnia magna*) 48-hr Static LC_{50}	>1,000 mg/L (PED)
Microtox (*Photobacterium phosphoreum*)	
Exposure:	EC_{50}
5 min.	650 mg/L
15 min.	4500 mg/L
30 min	4200 mg/L
Killifish (*Fundulus heteroclitus*) 96-hr Continuous Flow LC_{50}	>2,000 mg/L (PED)
Fathead Minnow (*Pimephales promelas*)	
96-hr Continuous Flow LC_{50}	>2,000 mg/L (PED)
96-hr Static LC_{50}	>1,000 mg/L (PED)

Environmental Assessment:

The environmental effects data for FC-203CE is fairly complete. Again, the PED data shows low toxicity to *Daphnia* which should be verified.

Recommendations for Additional Testing:

Algae and *Daphnia*.

13. FC-203CF

Environmental Assessment:

No environmental effects data for this product are available and a complete set of environmental effects data should be obtained.

Recommendations for Additional Testing:

BOD, COD, algae, *Daphnia*, fish, and Microtox.

14. FC-206CF

Environmental Assessment:

No environmental effects data for this product are available and a complete set of environmental effects data should be obtained.

Recommendations for Additional Testing:

BOD, COD, algae, *Daphnia*, fish, and Microtox.

15. L-4640 (New Foamer)

Testing is currently underway for a European PMN by NOTOX Laboratories:

1. Daphnia toxicity study (C2 EEC test method).
2. Fish toxicity (C1 method) using Zebra fish (*Brachydanio rerio*).
3. Modified Sturm test (C5) for ready biodegradability.

All testing for the European PMN is being done by GLP.

The following environmental effects data are from several 3M technical reports which are compiled in the report "Environmental Data and Information in Support of the PMN for Certain Chemical Substances Designated as L-4640", June 20, 1880.

Degradability:

BOD_5	<0.038 g/g
BOD_{10}	<0.038 g/g
BOD_{20}	<0.038 g/g
COD	0.41 g/g
Theoretical Oxygen Demand	0.75 g/g

Toxicity:

Acute Effect on Microbial Respiration	8% reduction in rate of oxygen depletion at 1,000 mg/L
Water Flea (*Daphnia magna*)	
48-hr Static LC_{50}	100 mg/L and 111 mg/L
Fathead Minnow (*Pimephales promelas*)	
96-hr Static LC_{50}	158 mg/L and 166 mg/L

Environmental Assessment:
Because of the importance of this material to future products, a full set of environmental effects data is needed. The environmental effects data not included in the PMN work or in the previous studies should be obtained: algae and Microtox.

Recommendations for Additional Testing:
Algae and Microtox.

16. Witcolate 7093 (RM 45666)

CAS # 73665-23-2

Witco Corporation (713-433-7281) has no ecotox information available. Witcolate 7093 is 55% water, 45% C6-C10 ethoxylated sulfate. They recommended Swisher for biodegradation information.

No information on EPA AQUIRE database nor in Verschueren.

Environmental Assessment:
No effects data is available. Testing depends on the likelihood that this material will be used in future products.

Recommendations for Additional Testing:
COD, BOD, algae, fish, *Daphnia*, and Microtox.

17. Triethanolamine

CAS # 102-71-6

Degradability:[31]

ThOD	2.04 g/g
BOD_5	nil 0.02 g/g with standard seed 0.17 g/g adapted sewage 0.03 g/g
BOD_{10}	0.02 g/g nil with std. diluted sewage
BOD_{15}	0.05 g/g
BOD_{20}	0.13 g/g

31 All degradability data are from Verschueren p 1150-1.

COD	1.50 g/g
BOD_5/COD	nil to 0.11
BOD_{20}/COD	0.09

Toxicity:[32]

Bacteria (*Pseudomonas putida*)	
Popul. Growth Inhib.	>10,000 mg/L (Verschueren p 1151)
Algae (*Microcystis aeruginosa*)	
Popul. Growth Inhib.	47 mg/L (Verschueren p 1151)
Green Algae (*Scenedesmus quadricauda*)	
7-day Static Popul. Growth Inhib.	1.8 mg/L (AQUIRE 2; 1980)
8-day Static Popul. Growth Inhib.	1.8 mg/L (AQUIRE 2; 1978)
8-day Static Popul. Growth Inhib.	715 mg/L (AQUIRE 2; 1978)[33]
Blue-green Algae (*Anacystis aeruginosa*)	
8-day Static Popul. Growth Inhib.	19 mg/L and 47 mg/L (AQUIRE 2; 1978)
Protozoa (*Entosiphon sulcatum*)	
72-hr Static Population Growth	56 mg/L (AQUIRE 2; 1980)
Protozoa (*Chilomonas paramecium*)	
48-hr Renewal Popul. Growth Inhib.	1,768 mg/L (AQUIRE 4; 1980)
Protozoa (*Uronema parduczi*)	>10,000 mg/L (Verschueren p 1151)
Bacteria (*Pseudomonas*)	
LC_0	10,000 mg/L (Verschueren p 1151)
Algae (*Scenedesmus*)	
LC_0	100 mg/L (Verschueren p 1151)
Algae (*Colpoda*)	
LC_0	160 mg/L (Verschueren p 1151)
Water Flea (*Daphnia*)	
LC_0	2,500 mg/L (Verschueren p 1151)
24-hr Static LC_{50}	1,390 mg/L (AQUIRE 2; 1977)
Brine Shrimp (*Artemia salina*)	
24-hr Static LC_{50}	5,600 mg/L (AQUIRE 2; 1974)

32 The toxicity data are a partial listing of the 16 tests on 10 species given in the AQUIRE database.

33 This value is from a different reference than the previous one.

Goldfish (*Carassius auratus*)

24-hr Static LC_{50}	5,000 mg/L (AQUIRE 2; 1979)
24-hr LC_{50} (85% TEA)	75,000 mg/L at pH 7 3,500 mg/L at pH 10.3 (Verschueren p 1151)

Environmental Assessment:
This material shows insignificant toxicity to *Daphnia* and fish.
However, it has a low BOD/COD ratio and will contribute to a low ratio in the product. In addition, it shows considerable toxicity to algae. For these reasons, it would be best not to use this material in products unless no alternative can be found or its concentration in the product will be extremely low.

The literature data is essentially complete for this material. Any testing on this material must be reported to US EPA under section TSCA 8(d).

Recommendations for Additional Testing:
None.

18. Urea

CAS # 57-13-6

Degradability:[34]

Degrades abiotically:
$H_2NCONH_2 + H_20 \text{ ---> } CO_2 + NH_3$

Degradation rate at 20°C	10.9 mg/L/hr
Degradation rate at 2°C	3.3 mg/L/hr
Concentration in domestic sewage	2 to 6 mg/L

Toxicity:[35]

Bacteria (*Pseudomonas putida*)	
Popul. Growth Inhib.	>10,000 mg/L (Verschueren p 1178)
Green Algae (*Scenedesmus quadricauda*)	
7-day Static Popul. Growth Inhib.	10,000 mg/L (AQUIRE 2; 1980)
8-day Static Popul. Growth Inhib.	10,000 mg/L (AQUIRE 2; 1978)

34 All degradability data are from Verschueren p 1178-9.
35 The toxicity data are a partial listing of 32 tests on 17 species from the EPA AQUIRE database.

Blue-green Algae (*Anacystis aeruginosa*)	
8-day Static Popul. Growth Inhib.	47 mg/L (AQUIRE 2; 1978)
Protozoa (*Entosiphon sulcatum*)	29 mg/L (AQUIRE 2; 1980)
72-hr Static Popul. Growth Inhib.	
Protozoa (*Chilomonas paramecium*)	
48-hr Popul. Growth Inhib.	2,683 mg/L (AQUIRE 4; 1980)
Water Flea (*Daphnia*)	
24-hr Static LC_{50}	10,000 mg/L (AQUIRE 2; 1977)
Creek Chub (*Semotilus atromaculatus*)	
24-hr LC_0	16,000 mg/L (AQUIRE 2; 1952)
24-hr LC_{100}	30,000 mg/L (AQUIRE 2; 1952)

Environmental Assessment:
Literature data indicates that this material shows insignificant toxicity to *Daphnia*, fish, and green algae. Furthermore, it degrades readily and it most likely would not be a problem in the product.

However, it does show toxicity to blue-green algae, and the low toxicity to green algae should be verified by our own tests if it is to be used in the product at high concentrations.

Recommendations for Additional Testing:
None.

19. Triton X-305

CAS # 9002-93-1 (PRISM shows Triton X-305 to be 70% this material with the composition of the remaining 30% not given).

Synonyms:
Poly(oxy-1,2-ethanediyl), alpha-[4-(1,1,3,3-tetramethylbutyl)phenyl]-omega-hydroxy-polyethylene glycol p-1,1,3,3-tetramethylbutylphenyl ether
Octoxinol
P-tert-octylphenoxypolyethoxyethanol

Vendor:
Rohm & Haas Company[36]

36 Independence Mall West, Philadelphia, PA 19105. Phone: 215-592-3000.

Toxicity:[37]

Bluegill (*Lepomis macrochirus*)

24-hr Static LC_{50}	3.5 mg/L (AQUIRE 1; 1975)
24-hr Static LC_{50}	16.2 mg/L (AQUIRE 1; 1975)
24-hr Static LC_{50}	1,080 mg/L (AQUIRE 1; 1975)
24-hr Flow-through LC_{50}	10.0 mg/L (AQUIRE 2; 1975)
96-hr Static LC_{50}	2.8 mg/L (AQUIRE 1; 1975)
96-hr Static LC_{50}	12.0mg/L (AQUIRE 1; 1975)
96-hr Static LC_{50}	531 mg/L (AQUIRE 1; 1975)
96-hr Flow-through LC_{50}	10.0mg/L (AQUIRE 2; 1975)
6-day Flow-through LC_{50}	9.6 mg/L (AQUIRE 2; 1975)

The reason for the high values for the 24-hr Static LC_{50} (1,080 mg/L) and for the 96-hr Static LC_{50} (531 mg/L) are not known.

The vendor for Triton X-305 (Rohm and Haas) has no data on the aquatic toxicity or biodegradability of Triton X-305. However, they are sending a data sheet on the aquatic toxicity of Triton X-100. Triton X-100 has a lower molecular weight than X-305 and they believe that the toxicity of X-305 is less than X-100 because X-305 is less surface active. Triton X-305 is not believed to degrade biologically. Rohm and Haas has recently sold their Triton product line to Union Carbide (1-800-752-1827) and will be transferring the business in the near future. The CAS number given by Rohm and Haas for the series is 9036-19-5. The following data is from AQUIRE on this CAS number.

CAS # 9036-19-5

Toxicity:[38]

Rainbow Trout (*Salmo gairdneri*)	
48-hr Static LC_{50}	7.2 mg/L (AQUIRE 2; 1978)
96-hr Static LC_{50}	7.2 mg/L (AQUIRE 2; 1978)
Marine Polychaete Worm (*Scolelepis fuliginosa*)	
48-hr Static LC_{50}	17.0 mg/L (avg. of 7 points)
96-hr Static LC_{50}	13.7 mg/L (avg. of 8 points) (AQUIRE 2; 1978)

37 The toxicity data are a partial listing of 13 tests on 5 species from the EPA AQUIRE database.

38 The toxicity data are a partial listing of 36 tests on 5 species from the EPA AQUIRE database.

Marine Polychaete Worm (*Capitella capitata*)

48-hr Static LC_{50}	8.2 mg/L (avg. of 6 points)
96-hr Static LC_{50}	6.0 mg/L (avg. of 8 points) (AQUIRE 2; 1978)

Aquatic Sowbug (*Idotea balthica*)

48-hr Renewal LC_{50}	10.0 mg/L (AQUIRE 3; 1972)
96-hr Renewal LC_{50}	5.0 mg/L (AQUIRE 3; 1972)

Environmental Assessment:

Both CAS numbers have a limited amount of toxicity data available which shows moderate toxicity. Since Triton X-305 is a major component of the CE products, we will need a complete set of data on this material in order in order to correlate the effects of the CE products to their formulation.

Recommendations for Additional Testing:

BOD, COD, algae, *Daphnia*, fish, and Microtox.