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DuPont Fluorotelomer Product Stewardship Update

Presented to

The United States Environmental Protection Agency

November 25, 2002

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Presentation Outline

- Introduction
  - Agenda, desired outcomes
  - Research approach overview
  - Overall DuPont Timeline & Milestones
- Toxicology & Descriptive Biology Update
  - Intermediate : Telomer BA
  - Polymers : Telomer Urethane, Telomer Acrylate
  - Surfactants : Telomer Phosphate
  - Overall Summary & Draft Hazard Assessment
- Exposure & Risk Characterization
  - Consumer & Occupational Exposure
  - Risk Characterization
- Environmental Fate & Effects
  - Environmental Compartments
  - Environmental Effects
  - Environmental Fate
- Summary, Conclusions, Discussion & Questions

DuPont PS Effort : *Product Focused*

DuPont CCAS & Haskell Laboratory

Analytical
- Product & Substrate Analysis
- Toxicology , Exposure & Fate work methods development and analysis
- Chemical "Standards"
- External Labs

Academic Collaboration

Communication

DuPont Chemical Solutions Enterprise

Product Stewardship Business Process

DuPont Haskell Laboratory

Toxicology
- Repeated Dose / One Generation Reproduction / Developmental
- Pharmacokinetics
- Dermal
- Inhalation
- ^{14}C Labeled Material

Human Health Risk Assessment

Environmental Fate & Effects
- Physical / chemical properties
- Environmental compartments
- Fate (abiotic & biotic)
- Effects : aquatic, terrestrial
- ^{14}C Labeled Material

DuPont CCER

Environmental Risk Assessment

input

Exposure
- Product Trails
- Mass Balance
- Human & Environmental Exposure Assessment
- Risk Characterization

DuPont CRG

DuPont Product Stewardship
Key Communications 2001 - Present

2001 :

Feb : DuPont meets with U.S. EPA to review Tox & EFE Plans & Results

April : DuPont presents Tox Studies at Society of Toxicology (SOT) Annual meeting

DuPont meets with Environment & Health Canada

May : DuPont meets with DEFRA, UK Env. Agency

Oct : DuPont presents initial data at Soc. Of Env. Tox & Chemistry (SETAC) Meeting

Dec : DuPont meets with U.S. EPA

2002 :

April : DuPont presents Tox Study Data at SOT Annual meeting

May : DuPont meets with UK Env. Agency; Dutch RIKZ / Univ. Amsterdam

June : DuPont meets with Environment & Health Canada

Nov. : DuPont presents at North America SETAC Meeting

DuPont meets with U.S. EPA

DuPont Fluorotelomer Product Groups: Intermediates, Surfactants, Polymers

1) ***Intermediates***

$CF_2=CF_2$ **(TFE)**

↓

$F(CF_2CF_2)_nI$ **(Telomer A)** n = 2-8

↓

$F(CF_2CF_2)_nCH_2CH_2I$ **(Telomer B)**

↓

$F(CF_2CF_2)_nCH_2CH_2OH$ **(*Telomer BA*)**

Straight Chain Alkyl

↓

$F(CF_2CF_2)_nCH_2CH_2OC(O)C(R)=CH_2$

Zonyl® TM ($R=CH_3$) ; **Zonyl® TAN** (R=H)

Sales Products

2) Surfactants / "Molecules"

- Anionic - ***Phosphate***, Carboxylate, Sulfonate
- Nonionic - ***Ethoxylate***
- Betaine

3) Polymers

- ***Acrylic***
- Ester
- Amide
- ***Urethane***
- Urea

5 **Test Compounds** Represent Large Per Cent of Product Line

Repeated-Dose Study Plan Overview

5 **Test Compounds**

Structures Represent

Majority of DuPont

Product Line

Products

Intermediate
- Telomer BA

Polymer
- Telomer Urethane
- Telomer Acrylate

Surfactant
- Telomer Phosphate
- Telomer Ethoxylate

Repeated-Dose Studies

Rat Model

- **90 Day Subchronic Oral Study**
- **One-Generation Reproduction**
- **Developmental Toxicity**

We continue to fill in our database, as we committed 1 May 2001.

DuPont Toxicology Studies Timeline*

Test Material	Work	2000 3Q	2000 4Q	2001 1Q	2001 2Q	2001 3Q	2001 4Q	2002 1Q	2002 2Q	2002 3Q	2002 4Q	2003 1Q	2003 2Q	2003 3Q	2003 4Q
Telomer Urethane Polymer	**90 Day Oral Repeat Dose, 1Gen Repro** (Rat)	■	■	■	■										
	Developmental Study (Rat)		■	■	■										
	Dermal Permeation (Rat)							■	■						
	90-Day Follow-Up Study										■	■			
Telomer BA Intermediate	90 Day Range-Finding Study	■	■												
	90 Day Oral Repeat Dose + 1Gen Repro (Rat)		■	■	■	■									
	Developmental Study Rangefinder			■											
	Genetic Toxicity: *In Vitro* Chrom Ab			■	■										
	Developmental Study (Rat)			■	■	■									
Telomer Ethoxylate Surfactant	90 Day Range Finding			■											
	90 Day Oral Repeat Dose,1Gen Repro (Rat)				■	■	■	■							
	Developmental Study Rangefinder				■										
	Developmental Study (Rat)				■	■	■								
Telomer Phosphate Surfactant	90 Day Range Finding				■										
	90 Day Oral Repeat Dose (Rat)				■	■	■	■							
	1Gen Reproduction Study (Rat)							■	■	■	■				
	Developmental Range Finder							■	■						
	Developmental Study (Rat)								■	■	■				
	28 Day Dermal Repeat Dose (Rat)										■	■	■		
	14-Day Inhalation Repeat Dose (Rat)										■	■			
Telomer Acrylate Polymer	90-Day Range Finding								■						
	90 Day Oral Repeat Dose,1Gen Repro (Rat)									■	■	■	■		
	Developmental Study Rangefinder									■					
	Developmental Study (Rat)									■	■	■			

Work Complete | **Work Underway** | **Projected Timing**

*** This is a proposed timeline and subject to change.**

DuPont Toxicity Studies : Rat Model Multiple Routes of Exposure

- Oral
  - 90-day subchronic, reproductive, and developmental toxicity
  - Dosing by gavage, male and female rats
  - Full battery of tissues examined

- Dermal
  - *In vitro* tests for dermal penetration – rat and human skin
  - *In vivo* tests – 28 day study, male rats

- Inhalation
  - 14/28 day study, male rats

Intermediate : Telomer BA
Study Summary & Timeline

$F(CF_2CF_2)_nCH_2CH_2OH$ n= 3 -6

Test Material	Study	2000 3Q	2000 4Q	2001 1Q	2001 2Q	2001 3Q	2001 4Q
Telomer BA Intermediate	90 Day Range-Finding Study	■	■				
	90 Day Oral Repeat Dose + 1Gen Repro (Rat)		■	■	■	■	
	Developmental Study Rangefinder			■			
	Genetic Toxicity: *In Vitro* Chrom Ab			■	■		
	Developmental Study (Rat)			■	■	■	

Work Complete

- 90 Day Subchronic Oral : NOEL 25 mg/kg/day
  Dose Levels : 25, 100, 250 mg/kg/day — Primary Target : Teeth
- Reproductive Toxicity : NOEL 25 mg/kg/day
  Dose Levels : 25, 100, 250 mg/kg/day — *not a selective reproductive toxin*
- Developmental Toxicity : NOEL 200 mg/kg/day
  Dose Levels : 25, 200, 500 mg/kg/day — *not a selective developmental toxin*

Polymer : Telomer Urethane
Study Summary & Timeline

$F(CF_2CF_2)_nCH_2CH_2OH$ (Telomer BA) → **Telomer Urethane Polymer**

n = 3 - 6 Straight Chain Alkyl

Aqueous Dispersion with surfactant

Test Material	Work	2000 3Q	2000 4Q	2001 1Q	2001 2Q	2001 3Q	2001 4Q	2002 1Q	2002 2Q	2002 3Q	2002 4Q	2003 1Q	2003 2Q	2003 3Q	2003 4Q
Telomer Urethane Polymer	90 Day Oral Repeat Dose + 1Gen Repro (Rat)	■	■	■	■										
	Developmental Study (Rat)		■	■	■										
	Dermal Permeation (Rat)							■	■						
	Nasal Lesion - Follow-Up Study										▪	▪			

■ Work Complete ▪ Work Underway

- 90 Day Subchronic Oral: LOEL 50mg/kg/day
  Dose Levels : 50, 250, 1000 mg/kg/day — Primary Target : Nose
- Reproductive Toxicity: No effects on reproduction at any dose
  Dose Levels : 50, 250, 1000 mg/kg/day — *not a selective reproductive toxin*
- Developmental Toxicity: No abnormalities or birth defects at any dose
  Dose Levels : 50, 250, 1000 mg/kg/day — *not a selective developmental toxin*

Polymer : Telomer Urethane
90 Day Oral Study (Rat) : Follow-Up

Purpose: to determine the cause and establish a no-effect level for nasal lesions (olfactory epithelial degeneration and necrosis)

Primary questions to address

–Are the lesions caused by telomer urethane polymer or surfactant? Reproducible?

–Can a NOEL be established?

Study Design

- 3 dose groups: telomer urethane polymer product, surfactant, and control
- Animals dosed with equivalent of high dose in 90 day study
- Sacrifice and evaluate nasal tissue at 2, 4 and 13 weeks as needed

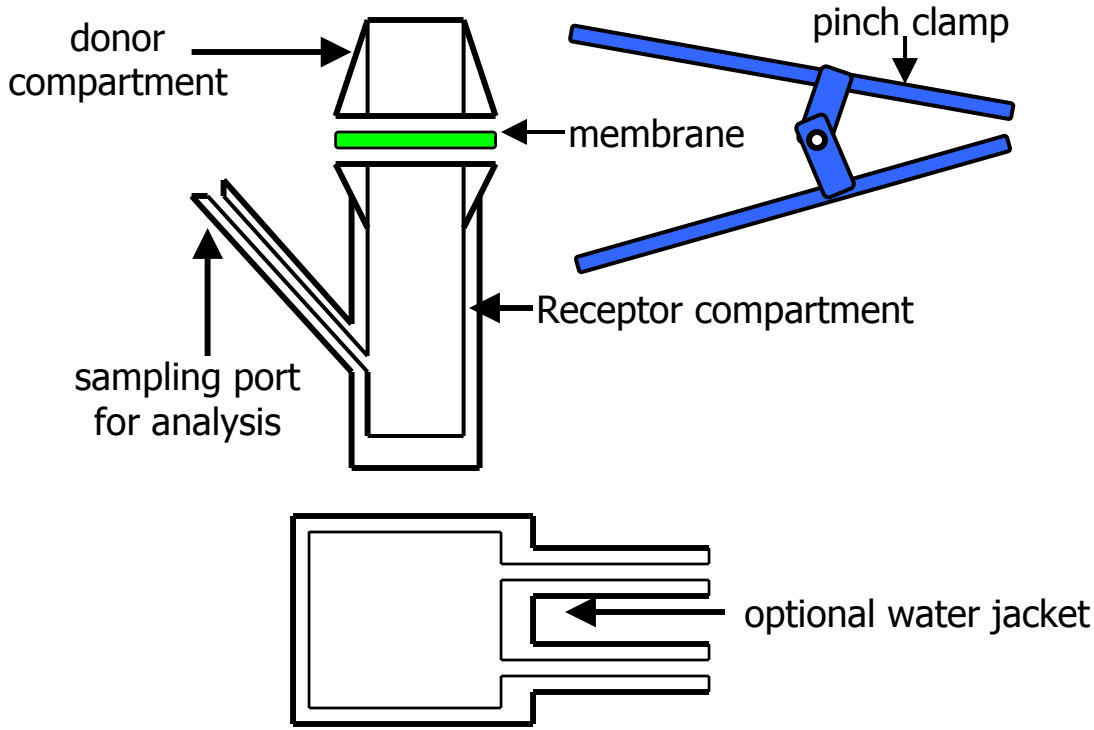
- Follow with 3 dose level study with either surfactant or polymer

Study started: 11/01/02

In Vitro Dermal Permeation with Telomer Urethane

- Purpose: To determine the permeability of the agent through rat and human skin
- Draft Guideline: OECD, 1999; ECETOC, 1993
- *In vitro* technique employing glass (static) diffusion cells have been shown to predict percutaneous absorption of various chemicals *in vivo*

Static Diffusion Cell : *In Vitro* Dermal Permeation



Saline receptor fluid

Polymer : Telomer Urethane
In-vitro Dermal Permeation

Methods

- 20 µl product solution was applied to rat epidermal membrane
- Total of 1234 µg fluorine in contact with rat skin for 6 hours
- 3 ml receptor fluid analyzed for total fluorine using Wickbold torch method

Results

- Total fluorine in receptor fluid was below the limit of detection (LOD) of 0.052 ppm; less than 0.013 % of urethane polymer permeated the rat skin
- Input for exposure and risk characterization

Polymer : Telomer Acrylate
Chemistry

- Aqueous emulsion polymerization of monomer composition :
  - $F(CF_2CF_2)_nCH_2CH_2OC(O)CH=CH_2$ n = 4 - 6

CBI Information has been redacted

  - MW > 40,000

- Test Substance for Acute Studies : product = aqueous dispersion of polymer in water with surfactants

- Test Substance for Repeated Dose Studies:
  - solid polymer washed free of surfactants, composition before and after washing verified as the same

Polymer : Telomer Acrylate
Toxicology Information

Acute Toxicity*:

- Oral Rat: ALD > 11,000 mg/kg
- Inhalation Rat: 4 hr: ALC = 590 mg/m^3
- Skin Irritation: Non-irritating
- Eye Irritation: Moderate, reversible irritation
- Sensitization: Not an irritant or sensitizer in multiple human patch tests

Aquatic Toxicity*

- Rainbow Trout : 96Hr. LC_{50} = 181 mg/L
- Daphnia Magna : 48Hr. EC_{50} = 234 mg/L
- Algae : 72Hr. EC_{50} = 36.2 mg/L

* data generated on aqueous dispersion product

Polymer : Telomer Acrylate
Subchronic Oral Study Range-Finder

- Test material: Telomer Acrylate Polymer Solids in water vehicle
- Doses:
  - 0, 1, 10, 100, 1000 mg/kg/day
  - 100% active test substance
- No clinical signs or body weight effects after 45 days at any dose
- Total fluorine levels assessed, steady-state appears to occur around 20 days into dosing
- Fluorine levels in blood are low

Polymer : Telomer Acrylate
Study Summary & Timeline

Test Material	Work	2002 1Q	2Q	3Q	4Q	2003 1Q	2Q	3Q	4Q
Telomer Acrylate Polymer	90-Day Range Finding		■						
	90 Day Oral Repeat Dose,1Gen Repro (Rat)			■	■	■	■		
	Developmental Study Rangefinder			■					
	Developmental Study (Rat)			■	■	■			

Work Complete **Work Underway**

- 90 Day Subchronic Oral: In Progress
  Dose Levels : 10, 100, 1000 mg/kg/day
- Reproductive Toxicity: In Progress
  Dose Levels : 10, 100, 1000 mg/kg/day
- Developmental Toxicity: In Progress
  Dose Levels : 10, 100, 1000 mg/kg/day
- Genetic Toxicity : Negative Ames, Chom Ab

Surfactant : Telomer Phosphate
Chemistry

$F(CF_2CF_2)_nCH_2CH_2OH$ (Telomer BA) n = 3 - 6

↓ P_2O_5, H_2O, isopropanol, NR_3

$[F(CF_2CF_2)_nCH_2CH_2O]_xP(O)(ONR_3H)_{3-x}$ X = 1-3

- Products by Process
- BL, B Telomer Distributions tailored to end-use
- Mixture of Mono-, Bis- and Pyro- Phosphate Esters
- Study material contains 25 wt% isopropanol as co-solvent

Surfactant : Telomer Phosphate
Timeline

Test Material	Work	2000		2001				2002				2003			
		3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Telomer Phosphate Surfactant	90-Day Range Finding				■										
	90 Day Oral Chronic Repeat Dose (Rat)				■	■	■	■							
	1Gen Reproduction Study (Rat)							■	■	■	■				
	Developmental Range Finder							■	■						
	Developmental Study								■	■	■				
	28 Day Dermal Repeat Dose (Rat)										■	■	■		
	14 Day Inhalation Repeat Dose (Rat)										■	■			

Work Complete **Work Underway**

- 90 Day Subchronic Oral: Female NOEL = 60 mg/kg/day
  Dose Levels : 10, 60, 300 mg/kg/day (35% a.i.)
  Male : NOEL < 10 mg/kg/day
  Target : liver
- Reproductive Toxicity: In Progress
  Dose Levels : 75, 500, 3500 mg/kg/day (20% a.i.)
- Developmental Toxicity: In Progress
  Dose Levels : 625, 1250, 2500 mg/kg/day (20% a.i.)
- Genetic Toxicity : Negative Ames

Surfactant : Telomer Phosphate
Toxicology Information

Acute Toxicity*

- Oral Rat: ALD > 17,000 mg/kg; LD_{50} > 25,000 mg/kg
- Inhalation Rat: 4 hr: ALC = 57 mg/m^3
- Skin Irritation: Not a skin irritant
- Eye Irritation: Minimal irritant
- Sensitization: Not an irritant or sensitizer

Aquatic Toxicity*

- Rainbow Trout : 96Hr. LC_{50} > 1,000 mg/L
- Daphnia Magna : 48Hr. EC_{50} >1,000 mg/L
- Algae : 1Q2003

Biodegradability* : OECD 301 70%

* studies conducted on 35% active test material containing isopropanol

Surfactant : Telomer Phosphate
Repeated-Dose Toxicology (Rat) : Summary

(35% a.i.; with isopropanol)

- 90 Day Subchronic Oral : (IPA containing, 35% a.i.)
  Dose Levels : 10, 60, 300 mg/kg/day
  Female NOEL = 60 mg/kg/day
  Male : NOEL < 10 mg/kg/day
- Inhalation (Two Week) : Pathology peer review in progress
  Dose Levels : 0.2, 2.0, 20 mg/m3
- Dermal (28 Day) : Study Started 29 Oct. 2002
  Dose Levels : 10, 100, 1000 mg/kg/day

(20% a.i.; no isopropanol)

- Reproductive Toxicity : Report in Progress
  Dose Levels : 75, 500, 3500 mg/kg/day
- Developmental Toxicity : Report in Progress
  Dose Levels : 625, 1250, 2500 mg/kg/day

*Surfactant : Telomer Phosphate**
90 Day Oral Study Results

Study Conclusion: Female (F) : NOEL = 60 mg/kg/day

Male (M) : NOEL < 10 mg/kg/day

300 mg/kg/day (35% active, with isopropanol)

- low body weight, food parameters (M)
- decreased red cell mass (M)
- liver: elevated enzymes, increased weights, necrosis (M&F)
- kidney: increased weights, hypertrophy (M)
- thyroid: hypertrophy (M&F)

60 mg/kg/day

- liver: elevated enzymes, increased weights, necrosis (M)
- kidney: increased weights, hypertrophy (M)
- thyroid: hypertrophy (M)

10 mg/kg/day

- liver: elevated enzymes, necrosis (M)

* study conducted on 35% active test material containing isopropanol

NOTE: Minimally elevated Beta Oxidation at 60 and 300 mg/kg/day

Surfactant : Telomer Phosphate
Reproduction Study Results

Study Conclusion: Report in Progress

(20% a.i., no isopropanol)

Study Design

- Doses : 75, 500, 3500 mg/kg/day
- P1 Pathology
  - the same target organs identified from 90-Day Subchronic Study with isopropanol-containing test material will be evaluated
- In-life Parameters
  - observed body weight effects (M & F) only at the high dose

Study Report Complete: January 2003

Surfactant : Telomer Phosphate
Developmental Study Results

Study Conclusion : Report in progress
(20% a.i., no isopropanol)

Study Design

- Doses : 625, 1250, 2500 mg/kg/day

Study Report Complete: December 2002

Surfactant : Telomer Phosphate
Two-Week Inhalation Study

Study Status: Report in preparation

Concentrations: 0.2, 2, and 20 mg/m^3

Exposures: 6 hrs/day x 9 days, 2-week recovery

Animals: 10 male rats/group

Additional Blood Analysis : total fluorine

- In-life: observed reduced body weight only at high dose
- Necropsy: No increased organ weights at any dose
- Microscopic findings: respiratory tract appears to be the most sensitive target

Study Report Complete : 1Q 2003

Surfactant : Telomer Phosphate
28 Day Dermal Study

Study Status: Study started 29 October 2002

- **Doses:** 10, 100, 1000 mg/kg/day
- Application: 6 hrs/day for 28 days
- Animals: 10 male rats/group
- Tissues: Skin and target tissues identified from oral study
- Additional Blood Analysis : total fluorine

Fluorotelomer Products
Repeated-Dose Study Observations

- Common across all DuPont Telomer Product Studies :
  - liver and thyroid hypertrophy : physiological response
  - in the rat : males more sensitive than females
- Target endpoints are unique to each test material
- Plasma and Urine Fluoride values indicate that test materials are processed differently
  - *functionality* appears to drive the observed unique endpoints

Hazard Assessment Example - "*Reference Dose*"

- This translates the animal data to a proposed "safe" human exposure level

Animal Model
Toxicity Testing

LOEL* = 50 mg/kg/day
Telomer Urethane

* expect NOEL to be near this value

10_A: Animals to Humans

10_S: Chronic vs. Subchronic

10_H: Human Variability

Uncertainty Factors

÷ 10

÷ 10

÷ 10

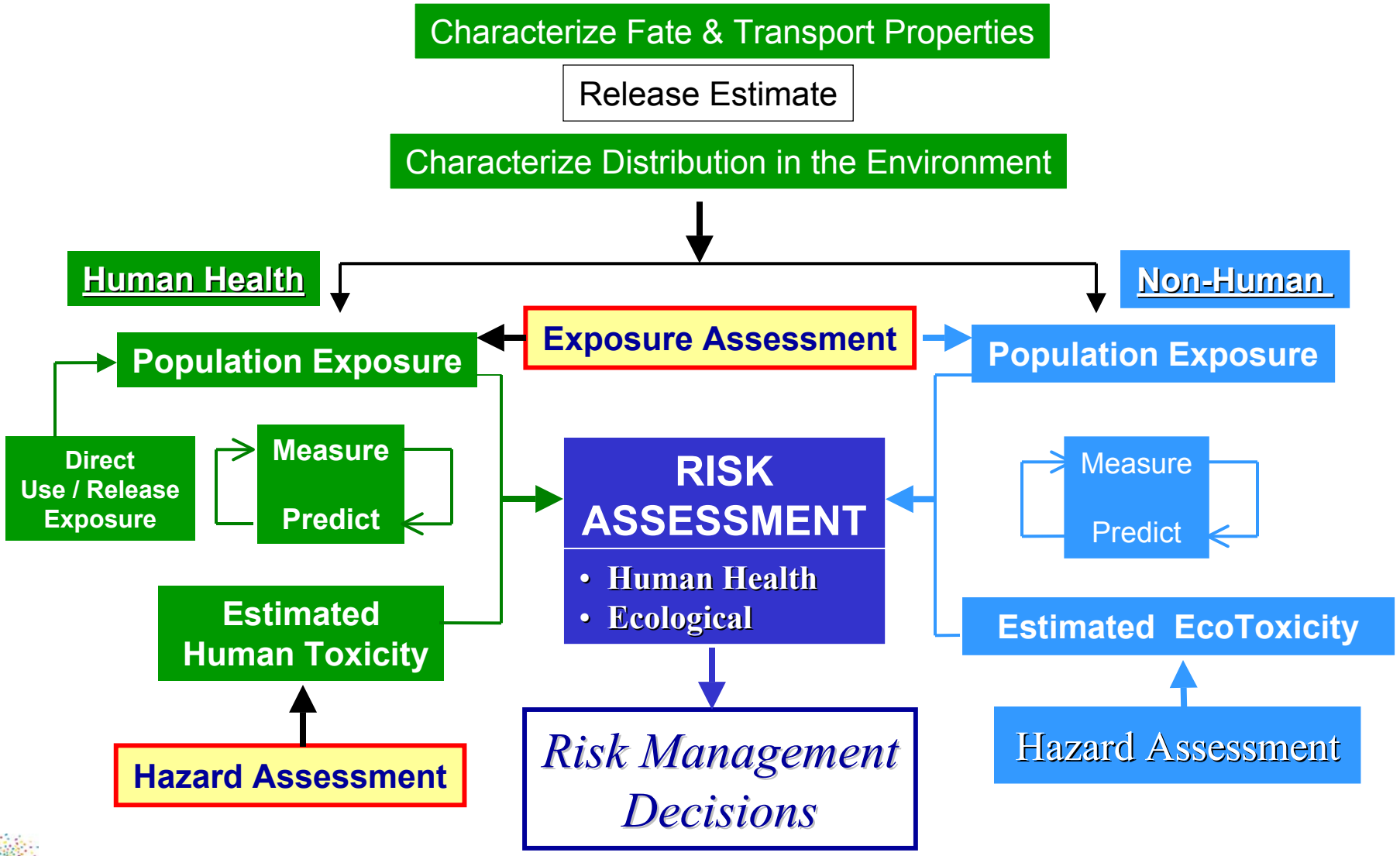
1000 fold**

**Using the highest value of uncertainty factor range (1-10)

Human Criterion

"Reference Dose" = 0.05 mg/kg/day

Risk Assessment Framework



How Did We Approach the Analysis?

- What types of products do we sell?
- Who buys our products?
- What consumer products contain our products?
- How do our customers use our products? In what form?
- How do consumers come in contact with our products?
- What is the magnitude of potential consumer exposure? How much? How often?
- How does exposure compare to what we know about potential hazard? ⇨ ***Risk Characterization***

Exposure Assessment Overview

Potentially Exposed Subpopulation	Food Wrap Paper	Carpets	Apparel
Consumer	* Ingestion	* Dermal * Indirect Ingestion	* Dermal

Potentially Exposed Subpopulation	Medical Fabric	Paints	Cleaning Products
Occupational			
Medical Worker	* Dermal		
Garment Worker	* Dermal		
Painter		* Dermal * Inhalation	
Custodial Worker			* Dermal

CBI Information has been redacted

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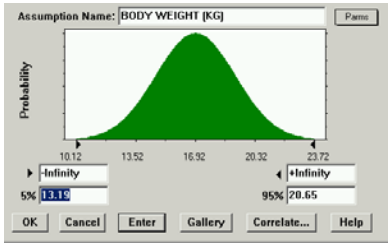
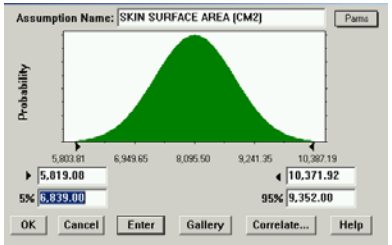
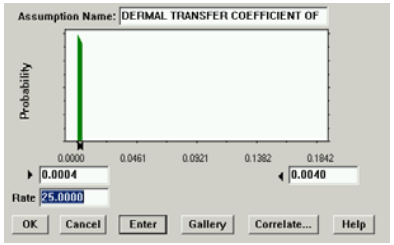
Critical Exposure Variables

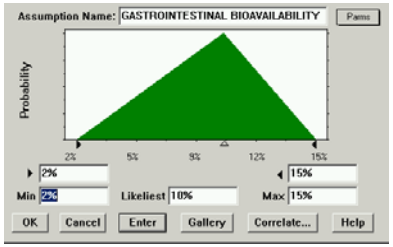
CBI Information has been redacted

- Developed point estimates for all necessary variables:
  - (1) Concentration of telomer urethane
  - (2) Loss of polymer over time
  - (3) Exposure period
  - (4) Skin surface area
  - (5) Dermal transfer coefficient
  - (6) Body weight
  - (7) Food surface area
  - (8) Bioavailability of the telomer urethane
- Also developed probabilistic inputs for key parameters in the analysis:









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Exposure Assessment Summary

- We have a great deal of confidence in this assessment and the process we are using.
- We believe that this information supports our belief that our products are safe for their intended uses.
- We are working to develop information with regard to community, ecological and integrated exposure
- We are using this process to identify data needs and to focus our research efforts
- We welcome your feedback on our initial efforts and your support in helping us to move forward

DuPont
Environmental Fate & Effects Work Plan

- We began with Physical-Chemical Property characterization for Telomer B and Telomer B Alcohol Intermediates
- Methods development progress now enables us to begin fate work on products

- Environmental Fate & Effects Study Plans : Product Focus
  - Physical- Chemical Properties
  - Environmental Effects :
    - Acute Data, BCF Screen , Chromic Fish ELS
  - Environmental Fate
    - Intermediate
    - Surfactants
    - Polymers

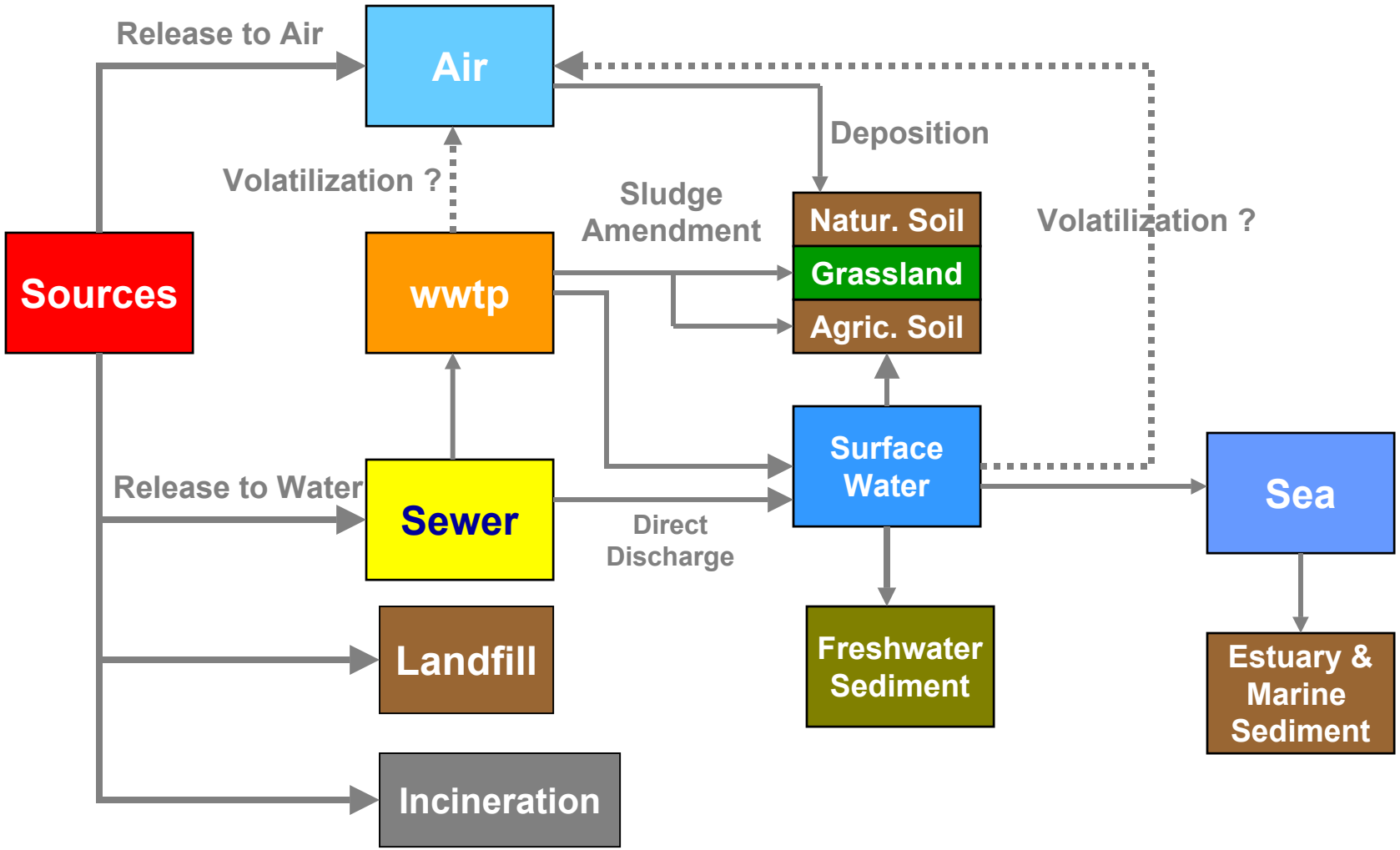
Physical - Chemical Properties : Water Solubility 6-2, 8-2 Telomer B Alcohols & Iodides

	Solubility			
	12°C	**25°C**	**37°C**	**60°C**
$C_6F_{13}CH_2CH_2OH$	12 ppm			17 ppm
$C_8F_{17}CH_2CH_2OH$	130 ± 30 ppb	140 ± 50 ppb	318 ± 176 ppb	225 ± 50 ppb
$C_6F_{13}CH_2CH_2I$	9 ppb			
$C_8F_{17}CH_2CH_2I$				< 10 ppb (LOQ)

- pH 3, 7, 9 ; T = 12, 25, 37, 60°C in deionized water
- see no differences in solubility versus pH

- Telomer Iodide water solubility very low; have decided not to pursue further testing and focus on products

Release, Fate and Effects Compartments



Potential Environmental Routes of Entry

	Intermediates	Surfactants	Polymers
Air	Particle adsorbed or vapor phase?	**Fugitive emissions from WWTP?**	
Soil	Air Deposition Soil - Landfill Land applied sludge	**Landfill** **Land applied sludge**	**Landfill** **Land applied sludge**
Sediment	WWTP Air Deposition direct discharge	**WWTP** **direct discharge**	**Direct discharge - point source**
Water	WWTP & Septic direct discharge surface presence?	**WWTP & Septic** **direct discharge** **surface presence?**	**WWTP & Septic**

DuPont : Acute Environmental Effects Data Summary

	Acute Fish mg/L	Acute Daphnid mg/L	Acute Algae mg/L
Telomer Alcohol Intermediate	96Hr LC_{50} = 316 fathead minnow	48Hr EC_{50} = 965	72Hr EC_{50} = 1,000
Telomer Phosphate Surfactant	96Hr LC_{50} > 1,000 rainbow trout	48Hr EC_{50} > 1,000	1Q2003
Telomer Ethoxylate Surfactant	96Hr TL_{50} = 100-140 rainbow trout	48Hr EC_{50} = 72	1Q2003
Telomer Urethane* Polymer	96Hr LC_{50} > 4,000 fathead minnow	48Hr EC_{50} = 500-5,000	72Hr EC50 = 870
Telomer Acrylate* Polymer	96Hr LC_{50} = 181 fathead minnow	48Hr EC50 = 234	72Hr EC50 = 36.2

*** tested as sales product including hydrocarbon surfactants**

Aquatic Bioconcentration Screening Study

Objective: To conduct *screening* studies evaluating the bioconcentration potential fluorotelomer-based products in fish

Methods:

- Juvenile fathead minnows, flow-through design
- Test Substances (consistent F concentration)
  - Negative Control
  - Positive control : PFOS
  - Surfactants : Telomer Phosphate; Telomer Ethoxylate
  - Intermediate : Telomer Alcohol
  - Polymer : Telomer Urethane
- Stock concentrations and tissue residues analysis – (total Fluorine)
  - Uptake phase – days 0, 2, 5, 7, 9, 12, 14
  - Depuration phase – days 16, 19, 21, 23, 26 28
- In-life complete, data evaluation on-going (complete 1Q2003)

Telomer Phosphate
Aquatic Chronic Fish (ELS) Toxicity Test

Objective: To determine a chronic LOEC (lowest observed effect concentration) and a chronic NOEC (no observed effect concentration).

Methods:

- OECD TG 210, OPPTS 850.1400, (90-d trout ELS)
- Dose response - dilution water and solvent (IPA) controls, 0.63, 1.25, 2.5, 5, and 10 mg/L Telomer Phosphate (a complex mixture)
- Analytical confirmation of test concentrations
- Analysis by LC/MS

Start Date : 8 November 2002

Est. Completion Date (in-life): 8 February 2003

DuPont Fluorotelomer-based Products
Environmental Effects Studies Timeline*

Test Materials	Work	2002 1Q	2Q	3Q	4Q	2003 1Q	2Q	3Q	4Q
8-2& 6-2 B, BA	Physical Properties								
Multiple Compounds Intermediate, Surfactant and Polymer	**Bioconcentration Factor (BCF) Screen** (Fathead Minnow) I								
Phosphate Surfactant	90 Day Fish ELS (GLP)								
	72Hr Algae (GLP)								
Ethoxylate Surfactant	90 Day Fish ELS (GLP)								
	72Hr Algae (GLP)								
Acrylate Polymer	Acute Aquatic Study Set								

Work Complete | Work Underway | Work Planned

* This is a proposed timeline and subject to change.

E-Fate Studies Approach

	Intermediates	Surfactants	Polymers
Abiotic	• Photolysis - Air • Photolysis - Water • Hydrolysis • Adsorption-Desorption (Kd) • Aging / Sequestration	• **Hydrolytic Stability** • **Adsorption-Desorption** • **Aging / Sequestration**	• **Hydrolytic Stability**
Biotic	• Aerobic : Ready, Inherent • Anaerobic	• **Respiration Inhibition** • **Aerobic : Ready, Inherent**	• **Respiration Inhibition** • **Aerobic : Ready, Inherent** • **Anaerobic ?**
	Telomer Research Program 8-2 Telomer B Alcohol	**DuPont Focus on Products**	

Telomer-Based Surfactants & Polymers
Abiotic Transformation : Hydrolytic Stability

Surfactants	Polymers
Phosphate, Ethoxylate	Urethane, Acrylate

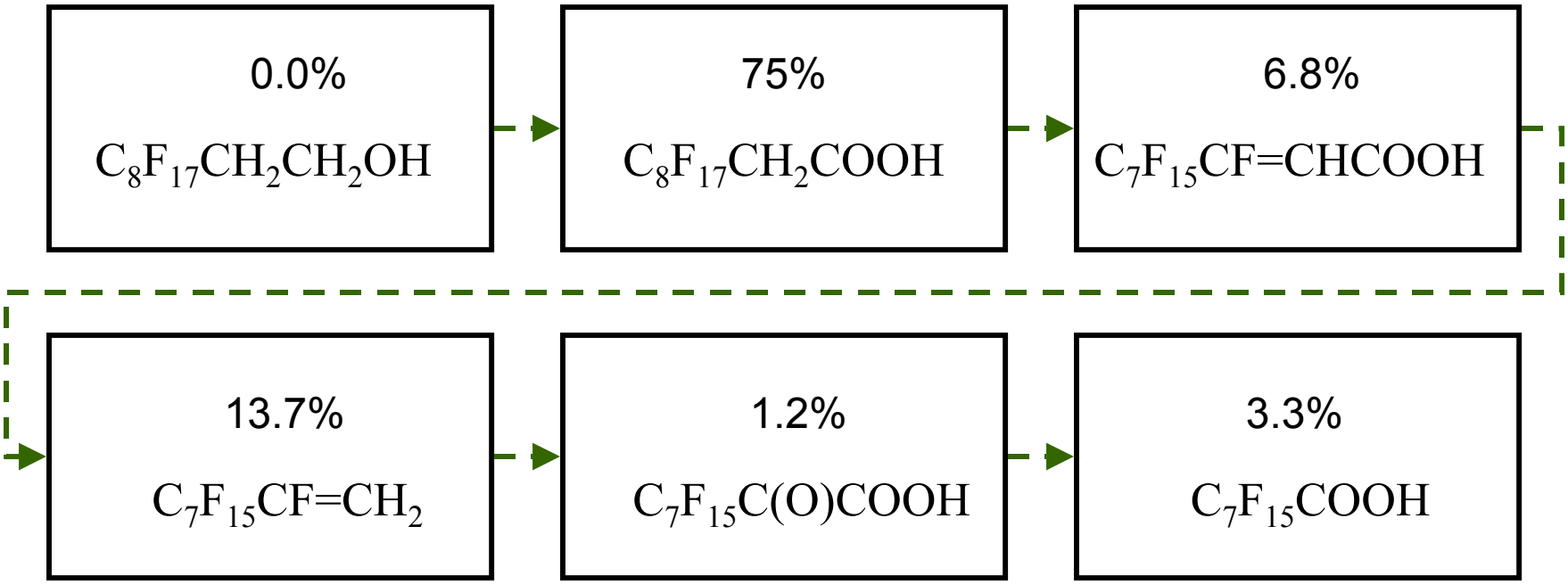
- Reactions in water are one of the most common means of non-biological degradation of substances in the environment.

- Aqueous stability tests should be performed at environmentally and biologically relevant pH's and temperatures.
  - pH 4, 7, 9 @ 50ºC
  - pH 1.2 @ 37ºC
- Four replicates at 0 and 5 Days

8-2 Telomer B Alcohol Biodegradation Studies

- "Ready" Biodegradability Screening
- "Inherent" Accelerated Biodegradability Screening
- "Cold" Study material
- Qualitative Identification & Analysis
- Enable method development

CATABOL Biodegradation Prediction $C_8F_{17}CH_2CH_2OH$



- The sum of the % values = 100
- The model *predicts* this will be the distribution of transformation products

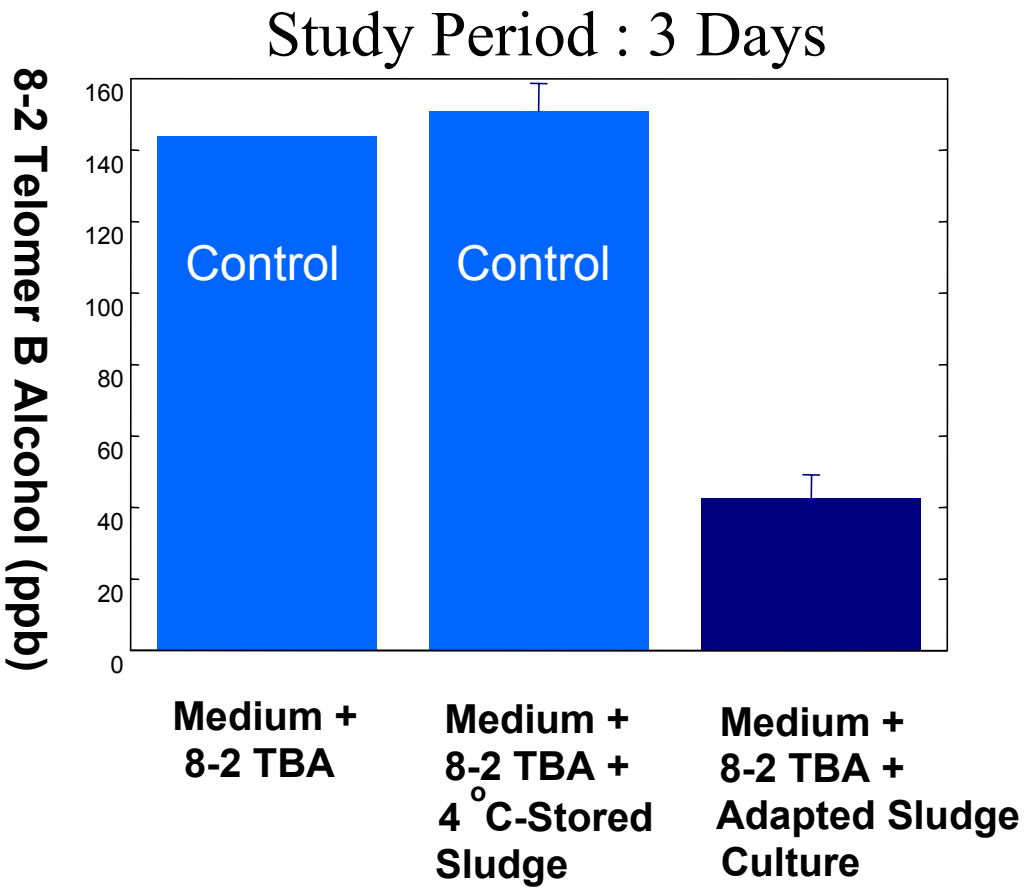
Accelerated Biodegradation Screening
Acclimated Municipal Sludge : $C_8F_{17}CH_2CH_2OH$ (8-2TBA)

Growth Medium:
E2-BSMYE buffer and minerals plus 20 g/L yeast extract as organic nutrient. Incubated at room temperature (21-25°C)

Inoculum source:
Municipal POTW (Incubated for 3 days)

Conclusion

- Test material is transformed with adapted sludge



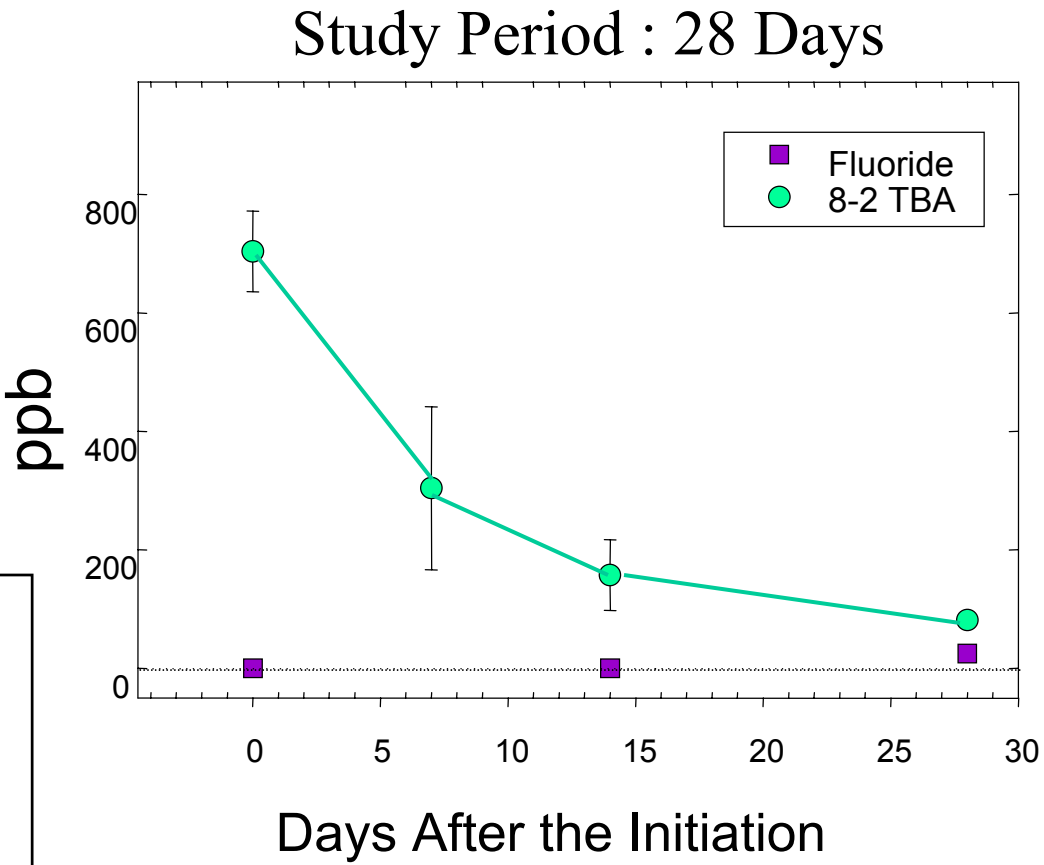
Modified "Ready" Aerobic Biodegradation Screening with Non-acclimated Municipal Sludge : $C_8F_{17}CH_2CH_2OH$

Growth medium:
OECD 301D mineral medium + 4 mg/L yeast extract as organic nutrient

Inoculum source:
Municipal POTW, fresh sludge; non-acclimated (Incubated for 0 - 28 days)

Conclusion

- Test material decreases
- No significant fluoride concentration increase



Accelerated Aerobic/Anaerobic Biodegradation Screening Acclimated Industrial Sludge : $C_8F_{17}CH_2CH_2OH$

- 8-2 TBA + Fresh Sludge
- CONTROL : 8-2 TBA, Sludge,2 mM NaCN

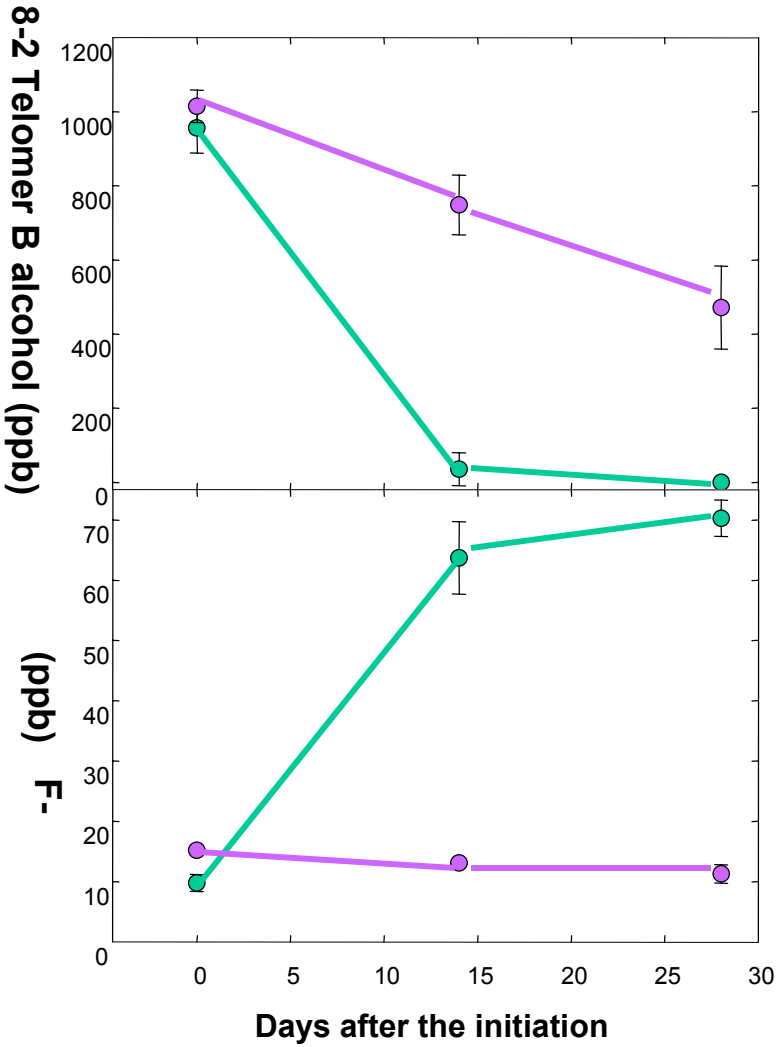
Growth Medium:
E2-BSMYE (1 g/L yeast extract as organic nutrient)

Inoculum source:
Industrial WWTP; acclimated (28 days)

Extraction Efficiency (%):
115.8 ± 11.0

Conclusion

- Test material is readily transformed
- Significant fluoride formation



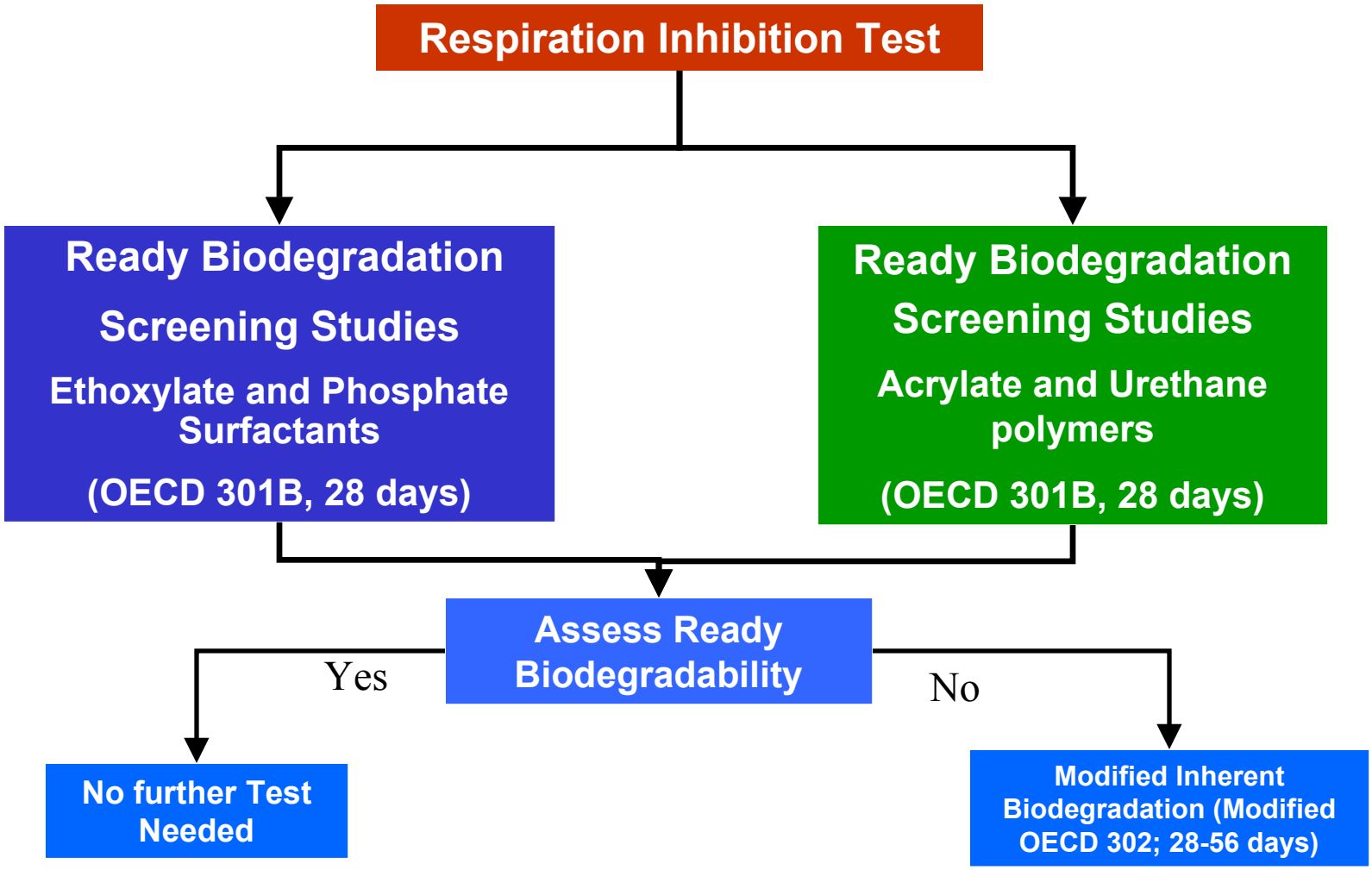
8-2 Telomer B Alcohol Biodegradation Screening Studies Summary

- Under modified "ready biodegradability" conditions, little de-fluorination occurred and $C_8F_{17}CH_2COOH$ appears to be the primary metabolite.

- Under modified accelerated conditions, transformation is rapid
  - Primary transformation products observed are :
    - $C_8F_{17}CH_2COOH$
    - $C_7F_{15}CF{=}CHCOOH$
    - Mass balance <50%; Other products/losses?

- On-going studies to understand controls, incomplete recoveries, and other transformation products

Telomer-based Surfactants & Polymers
Biodegradation Studies



Telomer-based Surfactants & Polymers

Aerobic "Ready" Biodegradation

Measured End Points:

- Time course of CO_2 evolution rate
- Time course of $[F^-]$ increase
- Total fluorine at the beginning and the end of the experiment
- Dissolved Organic Carbon (DOC) at zero (0) and 28 days

- Prework:
  - Total Organic Carbon (TOC) determination on test substance

DuPont Fluorotelomer-based Products
Environmental Fate Studies Timeline*

Test Materials	Work	2002 1Q	2Q	3Q	4Q	2003 1Q	2Q	3Q	4Q
$C_8F_{17}CH_2CH_2OH$	Respiration Inhibition		■						
	"Ready" Biodegradation Screening			■	■				
	"Inherent" Biodegradation Screening			■	■				
Telomer Phosphate Surfactant	Hydrolytic Stability					■			
	Respiration Inhibition				■	■			
	Biodegradation Screening					■	■		
Telomer Ethoxylate Surfactant	Hydrolytic Stability					■			
	Respiration Inhibition				■	■			
	Biodegradation Screening					■	■		
Telomer Urethane Polymer	Hydrolytic Stability					■			
	Respiration Inhibition					■	■		
	Biodegradation Screening					■	■		
Telomer Acrylate Polymer	Hydrolytic Stability				■	■			
	Respiration Inhibition					■	■		
	Biodegradation Screening					■	■		

Work Complete | Work Underway | Work Planned

* This is a proposed timeline and subject to change.

Chemical Standards

- To achieve quantitative precision in transformation studies
- **Isotopically - Labeled Standards**
  - M+5 : $C_7F_{15}{}^{13}CF_2CD_2CD_2OH$ (internal standard)
  - M+2 : $C_6F_{13}{}^{13}CF_2{}^{13}COOH$
- **"Cold" Standards**
  - $C_8F_{17}CH_2COOH$
  - $C_7F_{15}CF{=}CHCOOH$

DuPont Fluorotelomer-Based Products
Product Stewardship Summary

- *We have been proactive and diligent* in meeting our commitments to better understand toxicity, environmental fate & effects and exposure.
- *We are taking a comprehensive approach* to understanding exposure.
- *We are confident* that our products are safe for their intended uses.
- *We have programs in place* to learn more about our products: Toxicology, Environmental Fate & Effect, Exposure
- *We will continue to have an open & frequent dialogue* with Regulators, Customers, and Employees

Reflections, Discussion, Questions