

# Smart Math Saves Time and Improves Communication

---

March 7, 2018

Laura Nielsen, EPA & Susan Day, ERG



# Why Consider Upfront Design of Mathematical Organization and Sequence?

---

- The US Environmental Protection Agency (EPA) routinely collects information from reporters in the regulated community, mainly industry
- Data collections at EPA may support surveys, permit applications, questionnaires, regulatory requirements, and reports
- Per the Paperwork Reduction Act, an Information Collection Request (ICR) is required for any effort obtaining information from more than nine respondents
- ICRs require estimates of burden and cost to affected respondents

# Why Consider Upfront Design of Mathematical Organization and Sequence?

---

- Reporting Burden Estimation Methods have more than one possible formulation due to communicative, associative, and distributive laws of mathematics
- Certain formulations are better than others, particularly with respect to accuracy, transparency, and ease of maintenance during changes

# Why Consider Upfront Design of Mathematical Organization and Sequence?

---

## **Two key questions:**

- What is the simplest and easiest way to calculate burden estimates?
- What is the best way to provide clearly defined and consistent estimates?

# Why Consider Upfront Design of Mathematical Organization and Sequence?

---

**Key strategies for Smart Math applications include:**

- 1) *Simplify with Algebraic Reduction*: as opposed to using repetitious component calculations,
- 2) *Define Per-Submission Unit of Analysis*: with a focus on the respondent perspective; as a likely follow-on, consolidate multi-scale activity-level burdens into a unified scale,
- 3) *Avoid Potential Internal Inconsistencies*: with assessment of relationships between burden estimates for interrelated subpopulation categories, and implementation of ratio or other models, and
- 4) *Manage Temporal Effects*: with attention to timing issues and periodicity differences between reporter submission activities and ICR renewal needs.

# Why Consider Upfront Design of Mathematical Organization and Sequence?

---

## **Roadmap to the paper:**

- Background and basic heuristics
  - Where we cover some of the specific strategies and “how to” apply them
- Two cases studies
  - One from the TRI Program, and the other from TSCA Section 4 Testing Program
- Discussion of the benefits and long term implications of Smart Math
  - Where we tie the specifics of the examples and case studies to generalized benefits

# Background and Basic Heuristics

---

## **Overview of Analytical Considerations:**

- Simplify with Algebraic Reduction
- Assess levels of information and define per-submission unit of analysis
- Avoid potential internal inconsistencies via modeling
- Manage temporal effects

# Background and Basic Heuristics

## EPA TSCA Notice of Activity – Form A

<b>EPA</b>	<b>U.S. Environmental Protection Agency NOTICE OF ACTIVITY OF MANUFACTURE, IMPORT, OR PROCESSING – FORM A</b>		Submission Date:	
			Revised Date:	
<b>Part I – Submitter Identification</b>				
Manufacturer, Importer, Processor (in U.S.)	Name of Authorized Official		Mailing Address (street, city, zip code)	CBI*
	(first)	(last)		
	Company Name		Mailing Address (street, city, zip code)	
Technical Contact (in U.S.)	Name		Telephone Number	
	(first)	(last)		
* CBI refers to the term "Confidential Business Information." Mark (X) in the CBI box(es) if the submitter information is to be held confidential.				
<b>Part II – Chemical Substance Identity</b>				
CASRN	TSCA Inventory Chemical Name (if specific chemical identity is not CBI)			
Accession Number	Generic Chemical Name (if specific chemical identity is CBI)			

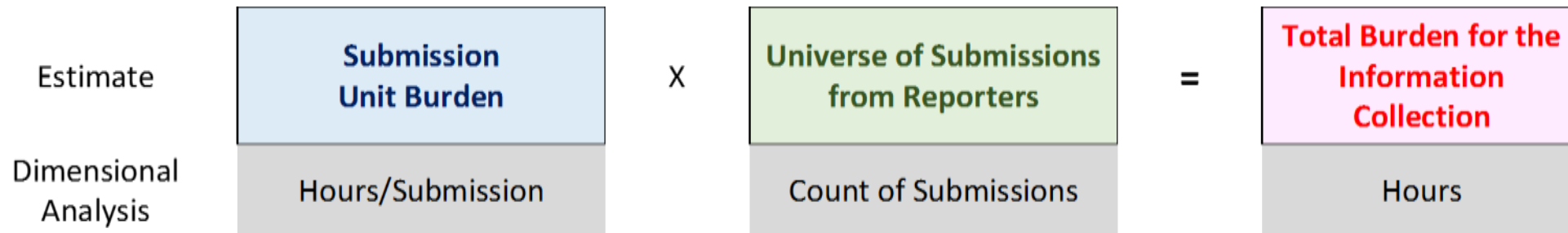


# Background and Basic Heuristics

## Simplify with Algebraic Reduction

---

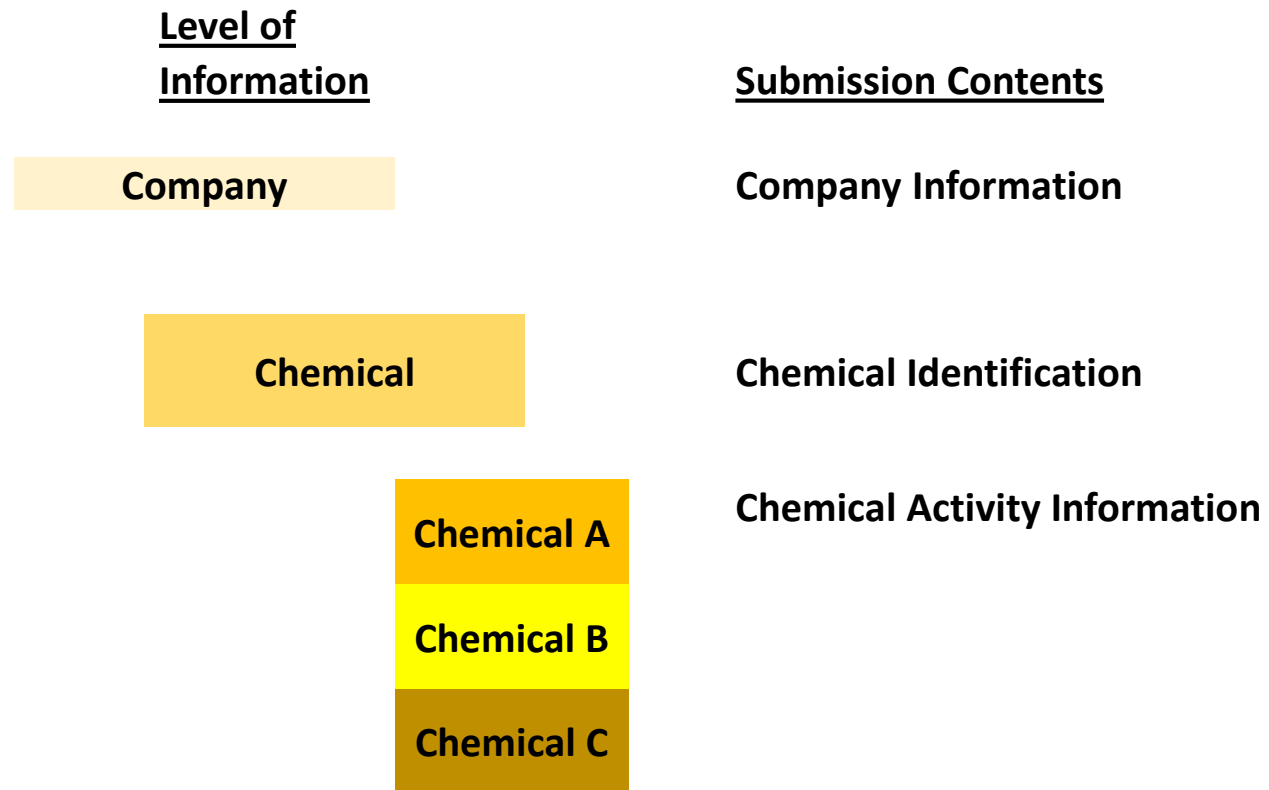
Keep Unit Burden and Universe Estimates Separated



# Background and Basic Heuristics

Assess Levels of Information, TSCA Notice of Activity Form A

---



# Background and Basic Heuristics

Define per-submission unit of analysis

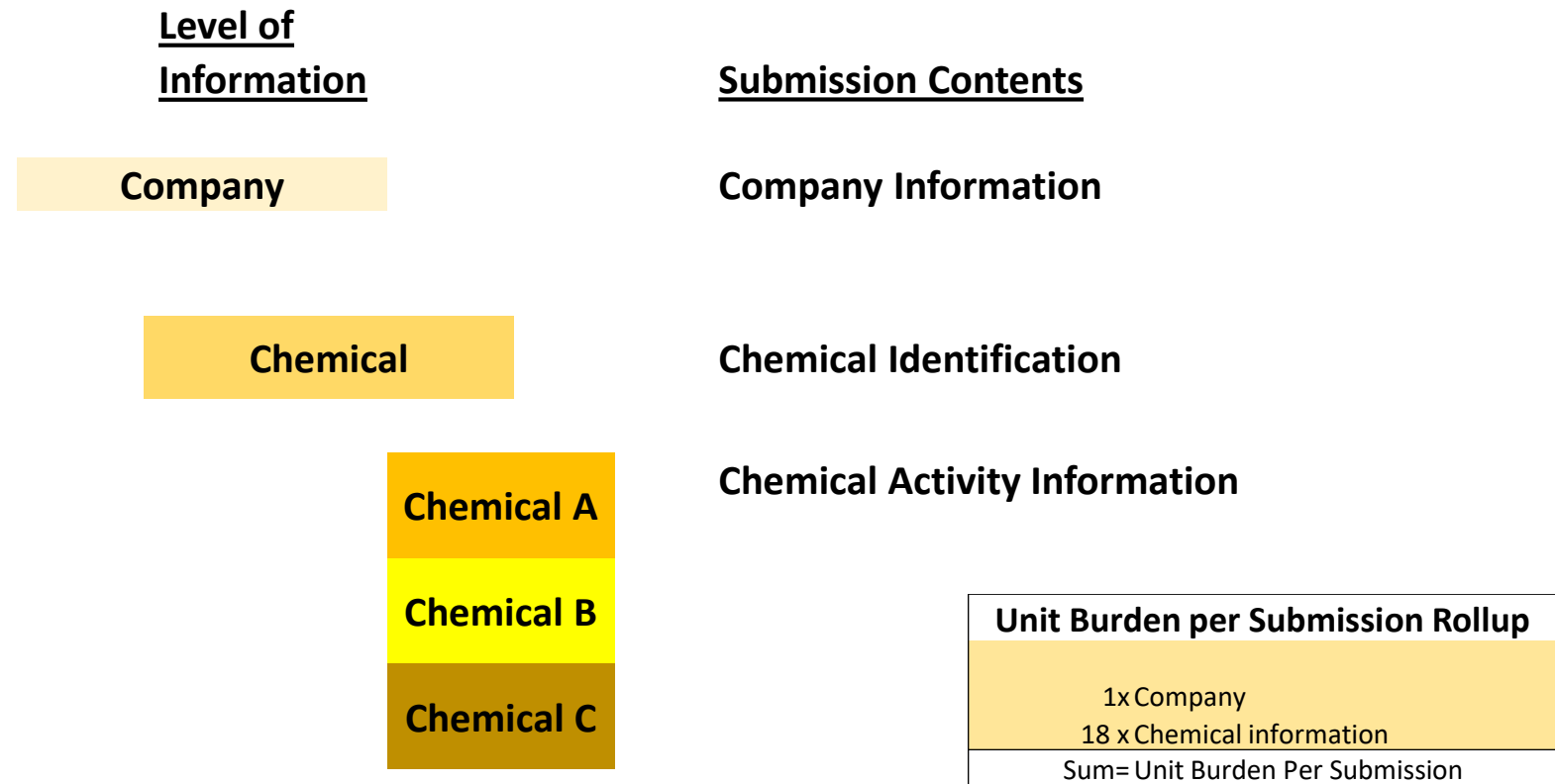
---

- The consideration of the per-submission unit of analysis flows directly from the assessment of levels of information
- As a starting point, consider the perspective of the reporter and the nature of the transaction or collection of transactions involved
- A typical approach is to consolidate activity-level unit burdens of differing metrics to a unified metric on a per-submission basis
- Response, Respondent definitions for PRA purposes are thereafter readily determined

# Background and Basic Heuristics

## Assess Levels of Information, TSCA Notice of Activity Form A

---



# Background and Basic Heuristics

Per Submission unit burden

(with rolled up activity-level unit burdens)

Notice of Activity:

Average Unit Burden Per Multi-Chemical Submission for Start-Up Conditions

Activity	Unit of Analysis	Total Burden (hours)
Rule Familiarization	Per Company	4.000
Multi-Chemical Compliance Determination (18 chemicals)	Per Company	1.994
Multi-Chemical Form Completion (18 chemicals)	Per Company	8.811
Recordkeeping	Per Company	0.125
<b>TOTAL, Average Unit Burden per Company</b>		<b>14.930</b>

# Background and Basic Heuristics

Assess levels of information

---

- Underlying structure of the collected data may involve multiple levels of information with differing units of measurement
- Definition of per-submission and associated per-response and per-respondent units important at onset
- Consolidating activity-level burdens to a unified metric in the per-submission unit burden requires scaling considerations
- Results can also provide useful metrics for concise communication

# Background and Basic Heuristics

## Avoid Potential Internal Inconsistencies via Modeling

Hypothetical Sets of Unit Burdens for Experienced and New Reporters

Experienced Reporter	Site	Managerial Technical Clerical			Total
		Rule Familiarization	2	2	
Site	Compliance Determination	0	2.5	0	2.5
Chemical	Calculations and Form Completion	20	40	20	80
	Recordkeeping	0.75	1.5	0.75	3
<b>Overall Total</b>					<b>89.5</b>

New Reporter	Site	Managerial Technical Clerical			Total
		Rule Familiarization	9	19	
Site	Compliance Determination	0	2.5	0	2.5
Chemical	Calculations and Form Completion	25	50	25	100
	Recordkeeping	0.75	1.5	0.75	3
<b>Overall Total</b>					<b>133.5</b>

Smart Math: One Set of Unit Burdens for Base Conditions Plus a Ratio Model

Experienced Reporter	Site	Managerial Technical Clerical			Total
		Rule Familiarization	2	2	
Site	Compliance Determination	0	2.5	0	2.5
Chemical	Calculations and Form Completion	20	40	20	80
	Recordkeeping	0.75	1.5	0.75	3
<b>Overall Total</b>					<b>89.5</b>

**First-Time Factor (FTF) = 1.49**

# Background and Basic Heuristics

Avoid potential internal inconsistencies via modeling

---

- One source of internal inconsistency is the provision of highly specified activity-level unit burdens outside of base conditions. Note: This practice also produces a false sense of precision
- Solution is to model the relationships between the base conditions and the alternate conditions at a higher level aggregate.
- A typical application involves the development of an estimate of burden for a subpopulation of new reporters. In such instances, a ratio model, called the First Time Factor (FTF) characterizes the uptick associated with inexperience.



# Background and Basic Heuristics

Manage temporal effects

## Test Rules Annual Average Burden and Cost for the ICR Renewal Period

Burden Category	3-Year Cycle Total Burden (Hours)			Annual Average Burden (Hours)		Annual Average Cost (2014\$)	
	Year 1	Year 2	Year 3	Per Chemical	Total	Per Chemical	Total
Test rules' activities and transmittals for the full battery of tests	7,460			249	2,487	\$18,074	\$180,744
Number of Responses and Respondents <sup>1</sup>	10			10		10	

<sup>1</sup>Ten chemicals are tested, based on the assumption that two test rules address five chemicals each. Also, one sponsor per chemical is assumed.

# Background and Basic Heuristics

Manage temporal effects

---

- When the natural time scale of the information collection is some period other than annual, problems can be encountered with respect to proper accounting and clarity in presentations
- Define the most sensible time period and estimate per-submission unit burden and total burden estimates for that time period
- Recalculate as needed: typically for annual and three-year period

# Case Study:

## Toxics Release Inventory

## Ratio Based Burden Methodology (RBBM)


---

- Eligible facilities report annually to EPA on the release and waste management of over 600 chemicals
- Facilities report this information on Form R and Form A
  - Form level burden
  - Facility level reporting activities
- In 2011, EPA undertook a methodology revision
  - Existing methodology developed in a piecemeal fashion
  - Artificially complex system resulted that was over-specified and conveyed a false sense of precision

# Case Study: TRI Program RBBM

## TRI Form R

Form Approved OMB Number: 2025-0009  
Approval Expires: 11/30/2017 Page 1 of 6

 <b>EPA</b> United States Environmental Protection Agency		<b>FORM R</b> Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986, also Known as Title III of the Superfund Amendments and Reauthorization Act		TRI Facility ID Number _____
				Toxic Chemical, Category, or Generic Name _____
This section only applies if you are revising or withdrawing a previously submitted form, otherwise leave blank.		<b>Revision (Enter up to two code(s))</b> _____		<b>Withdrawal (Enter up to two code(s))</b> _____
<b>IMPORTANT: See instructions to determine when "Not Applicable (NA)" boxes should be checked.</b>				
<b>PART I. FACILITY IDENTIFICATION INFORMATION</b>				
<b>SECTION 1. REPORTING YEAR</b> _____				
<b>SECTION 2. TRADE SECRET INFORMATION</b>				
2.1	Are you claiming the toxic chemical identified on page 2 as a trade secret? <input type="checkbox"/> Yes (Answer question 2.2; attach substantiation forms)	<input type="checkbox"/> No (Do not answer 2.2; go to Section 3)	2.2	Is this copy <input type="checkbox"/> Sanitized <input type="checkbox"/> Unsanitized (Answer only if "Yes" in 2.1)
<b>SECTION 3. CERTIFICATION (Important: Read and sign after completing all form sections.)</b> I hereby certify that I have reviewed the attached documents and that, to the best of my knowledge and belief, the submitted information is true and complete and that the amounts and values in this report are accurate based on reasonable estimates using data available to the preparers of this report.				
Name and official title of owner/operator or senior management official:		Signature:		Date signed:
<b>SECTION 4. FACILITY IDENTIFICATION</b>				
4.1	Facility or Establishment Name	TRI Facility ID Number		
	Physical Street Address	Mailing Address (if different from physical street address)		
	City/Country/Tribe/State/ZIP Code	City/State/ZIP Code	Country (Non-US)	
4.2	This report contains information for: (Important: Check a or b; check c or d if applicable)			
	a. <input type="checkbox"/> An entire facility	b. <input type="checkbox"/> Part of a facility	c. <input type="checkbox"/> A federal facility	d. <input type="checkbox"/> GOCO

# Case Study: TRI Program RBBM

Pre-RBBM Complexity: Numerous Burden Factors and Chemical Counts, 96 Factors

**R**

		Managenal	Technical	Clerical	Total
Form R nonPBT, subsequent years	Facility	Rule Familiarization		0	0
	Facility	Compliance Determination		0.25	1
			Calculations and Form		
	Form	Completion		0.32	6.89
	Form	Recordkeeping		0	4
					0
nonPBT, subsequent year					5
nonPBT, first year					
PBT, subsequent year					
PBT, first year					

**A**

		Managenal	Technical	Clerical	Total
Form A nonPBT, subsequent years	Facility	Rule Familiarization			
	Facility	Compliance Determination			
			Calculations and Form		
	Form	Completion			
	Form	Recordkeeping			
nonPBT, subsequent year					
nonPBT, first year					
PBT, subsequent year					
PBT, first year					

# Case Study: TRI Program RBBM

---

## Levels of information relevant to TRI reporting include:

- Facilities that report to TRI
- One or more chemicals reported on a Form R/Form A
- Subpopulations identified
  - PBT, non-PBT chemicals
  - First year and subsequent year reporters

# Case Study: TRI Program RBBM

---

## Per Submission Unit of Analysis

- For Form R (single chemical): RBBM consolidates numerous factors within the base “Form R unit burden” to yield one unit burden per Form R. Rollup includes components of activities in respective labor categories (e.g. technical labor of rule familiarization)
- For Form A (one or more chemicals): RBBM applies a ratio model, A/R
- RBBM permits the estimation of total burden by multiplying just one unit burden by the total number of chemicals for each type of form

# Case Study: TRI Program RBBM

---

## Key Factors (Reduced from 96) within RBBM's Reformulated Structure

- Nominal Form R unit burden – base number for entire methodology
- Form A unit burden - defined as *Nominal Form R unit burden* multiplied by  $A/R$ , a model of the ratio of Form A single-chemical burden to Form R burden
- First Time Filer Factor ( $FTF_f$ ) – used to estimate first-time filing burden for new entrants to reporting community
- PBT/non-PBT ratio (=1) – removes separate distinct subpopulation estimate for PBT chemicals



# Case Study TRI Program RBBM

## Ratio-Based Burden Methodology

### Two Unit Burdens; Two Chemical Counts; One Wage Rate

#### Steady State Total Burden Calculation

**Steady State Total Burden**

= Form R Burden + Form A Burden + Non-Form Burden

= Nominal Form R Unit Burden \* **# Form R Chemicals**

+ [Nominal Form R Unit Burden \* (A/R) \* (**# Form A Chemicals**)] + Non-Form Burden

#### First-Time Filer Estimation

**First-Time Filer Burden**

=  $FTF_f$  \* (Relevant Steady State Burden)

=  $FTF_f$  \* [(Nominal Form R Unit Burden \* **# New Form R Chemicals**)]

+ [(A/R) \* Nominal Form R Unit Burden \* **# New Form A Chemicals**]

#### Cost Conversion

**Steady State Total Cost = (Steady State Total Burden) \* WAWR**



# Toxics Release Inventory Ratio Based Burden Methodology (RBBM)

---

## Results

- Reduce the per-submission unit burden calculation to one base number, the Nominal Form R burden with the associated Form A unit burden determined by the ratio model A/R
- Avoids internal inconsistencies by eliminating activity-level unit burdens for similar subpopulations, replacing each system with ratio models: nonPBT/PBT (=1) and  $FTF_f$
- Bottom line – With fewer factors and smaller spreadsheets, analysts spend less time and effort generating TRI reporting burden estimates

# Case Study: TSCA Section 4 Testing Restructured Methodology

---

- Under TSCA Section 4, EPA has authority to require chemical manufacturers and processors to test existing chemicals
- Reporters submit a collection of transmittals pertaining to testing management and test results
- In 2015, EPA redesigned burden estimation methodology in order to improve transparency and ease of maintenance for future ICR renewals

# Case Study: TSCA Section 4 Testing

## Levels of Information

---

### Assessing Levels of Information, TSCA section 4 Test Rule Example

#### Level of Information

Consortium of Sponsors

Chemicals Subject to Test Rule

Test 1

Test 2

Test 3

Test 4

Test 5

Test 6

Test 7

Test 9

Test 10

#### Submission Contents

(per test)

Letter of Intent

Study Plans

Progress Reports (certain tests)

Final Reports

Robust Summaries

3-Year Time Period

# Case Study: TSCA Section 4 Testing

---

- A more natural organizational approach is developed that better reflects the information collection
- Recognition that activities, including transmittals, center around the requirements for chemicals in test rules
- Per submission response unit is redefined as “per chemical”

# Case Study: TSCA Section 4 Testing

## Summary of Transmittals According to the Redefined Per-Submission Unit of Analysis

Respondent Activities	Total Counts, Three Year Period
<u>Interim Reports</u>	
Letter of Intent/Study Plans	1
Prepare Annual Progress Reports	5
<u>Final Reports</u>	
Short Duration Studies	7
Recordkeeping	7
Long Duration Studies	3
Recordkeeping	3
Robust Summaries	1
<p><b>Notes:</b></p> <ol style="list-style-type: none"> <li>1. A response is defined as the collection of related activities involving a battery of ten tests (seven short; three long) all of which pertain to one specified chemical. See Table x for additional detail.</li> <li>2. Long duration studies are completed in three years; short duration studies are completed in one year. Only long term studies require annual progress reports.</li> <li>3. Ten percent of studies are expected to be accompanied by robust summaries because they are optional.</li> </ol>	

# Case Study: TSCA Section 4 Testing

Submission Unit Burden and Cost per Chemical, 3-Year Cycle  
(2014\$)

Respondent Activities	Total Counts Three Year Period#	Burden per Activity (hours)	Unit Burden per Chemical (hours)	Cost per Activity	Unit Cost per Chemical
<u>Interim Reports</u>					
Letter of Intent/Study Plans	1	40	40	\$2,889	\$2,889
Prepare Progress Report	5	8	40	\$578	\$2,889
<u>Final Reports</u>					
Short Duration Studies	7	52	364	\$3,803	\$26,624
Recordkeeping	7	1	4	16	\$109
Long Duration Studies	3	95	285	\$6,933	\$20,799
Recordkeeping	3	1	2	\$16	\$47
Robust Summaries	1	12	12	\$867	\$867
<b>Totals</b>			<b>746</b>		<b>\$54,223</b>

# Background and Basic Heuristics

Manage temporal effects

## Test Rules Annual Average Burden and Cost for the ICR Renewal Period

Burden Category	3-Year Cycle Total Burden (Hours)			Annual Average Burden (Hours)		Annual Average Cost (2014\$)	
	Year 1	Year 2	Year 3	Per Chemical	Total	Per Chemical	Total
Test rules' activities and transmittals for the full battery of tests	7,460			249	2,487	\$18,074	\$180,744
Number of Responses and Respondents <sup>1</sup>	10			10		10	

<sup>1</sup>Ten chemicals are tested, based on the assumption that two test rules address five chemicals each. Also, one sponsor per chemical is assumed.



# TSCA Section 4 Testing Restructured Methodology

---

## Results

- Multiple levels of information and associated assumptions are compartmentalized and better managed
- Calculations are more intuitive and easier to follow
- Roll-up to per-submission unit burden estimates is logical and comprehensive
- Bottom line - condensed calculation procedures means fewer spreadsheets to check in quality control work, and more transparency in per-response unit burden and total burden, which improves estimate face validity

# Benefits of Smart Math

---

- Accuracy and internal consistency assured
- Reports with high integrity and high reliability
- Intuitive unit burden per submission
  - Troubleshooting
  - Communications
  - Back-of-the-envelope
- Faster and cheaper
- Long term sustained benefits

# Questions?

---

## **Contact Information:**

Laura Nielsen

US EPA Office of Chemical Safety and Pollution Prevention

Nielsen.laura@epa.gov

Susan Day

Eastern Research Group

Susan.day@erg.com

