SPF Chemistry Makes It A Safe Product

2018 SPFA Convention & Expo Workshop

Presented by

George R. Thompson, Ph.D. and Brian Fogg, M.S.

CCS

Chemical Compliance Systems, Inc.

"Anticipating the Unanticipatable"

ANTITRUST POLICY STATEMENT FOR SPRAY POLYURETHANE FOAM ALLIANCE MEETINGS

- It is and shall remain the policy of the Spray Polyurethane Foam Alliance ("SPFA"), and it is the continuing responsibility of every SPFA member company, SPFA meeting or event participant, as well as SPFA staff and leadership to comply in all respects with federal and state antitrust laws. No activity or discussion at any SPFA meeting or other function may be engaged in for the purpose of bringing about any understanding or agreement among members to (1) raise, lower or stabilize prices; (2) regulate production; (3) allocate markets; (4) encourage boycotts; (5) foster unfair or deceptive trade practices; (6) assist in monopolization; or (7) in any way violate or give the appearance of violating federal or state antitrust laws.
- Any concerns or questions regarding the meaning or applicability of this policy, as well as any concerns regarding activities or discussions at SPFA meetings should be promptly brought to the attention of SPFA's Executive Director and/or its legal counsel.

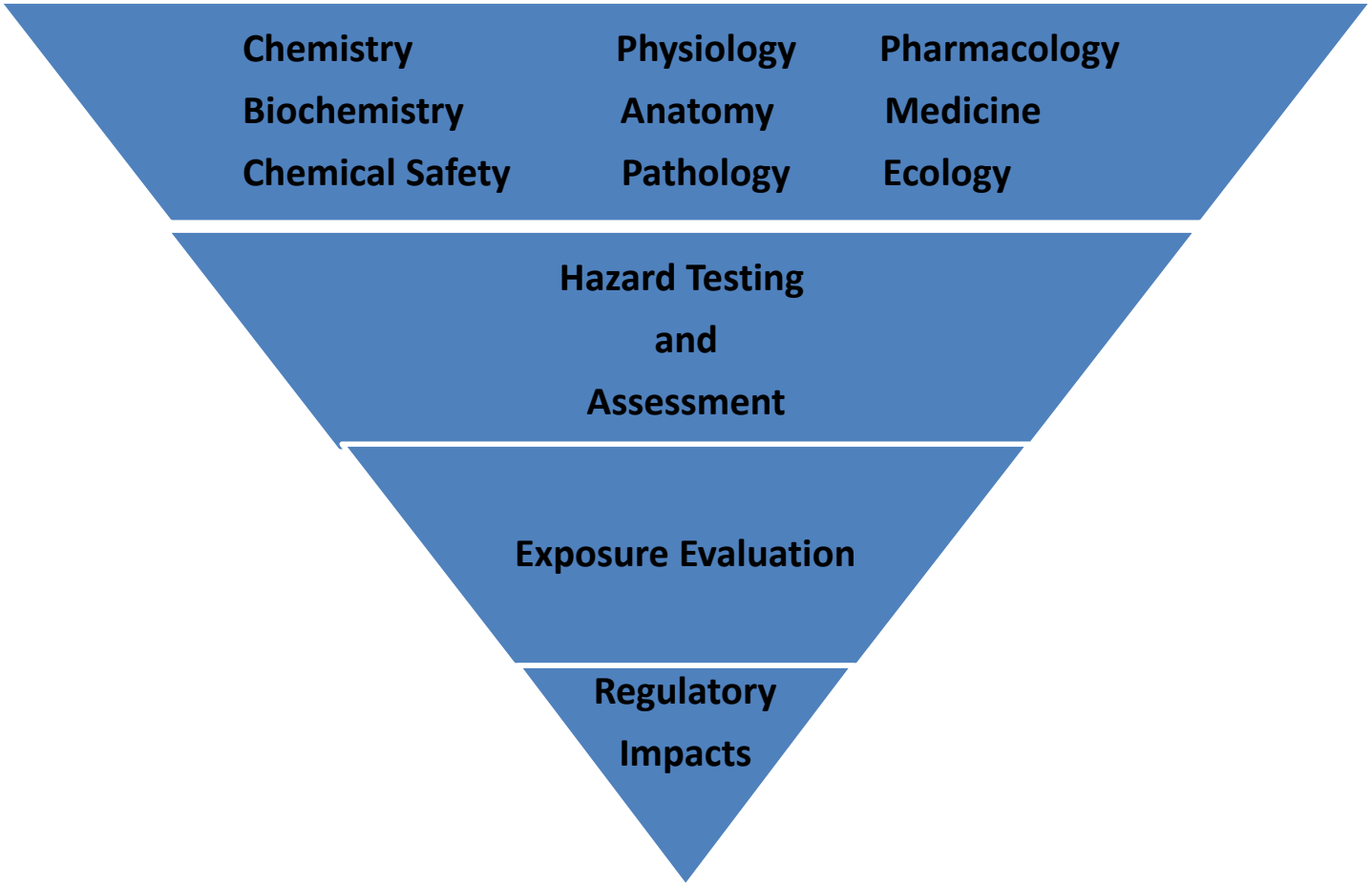
Pre-Workshop Quiz

1. **How many of you represent manufacturers?**

2. **How many of you represent installers?**

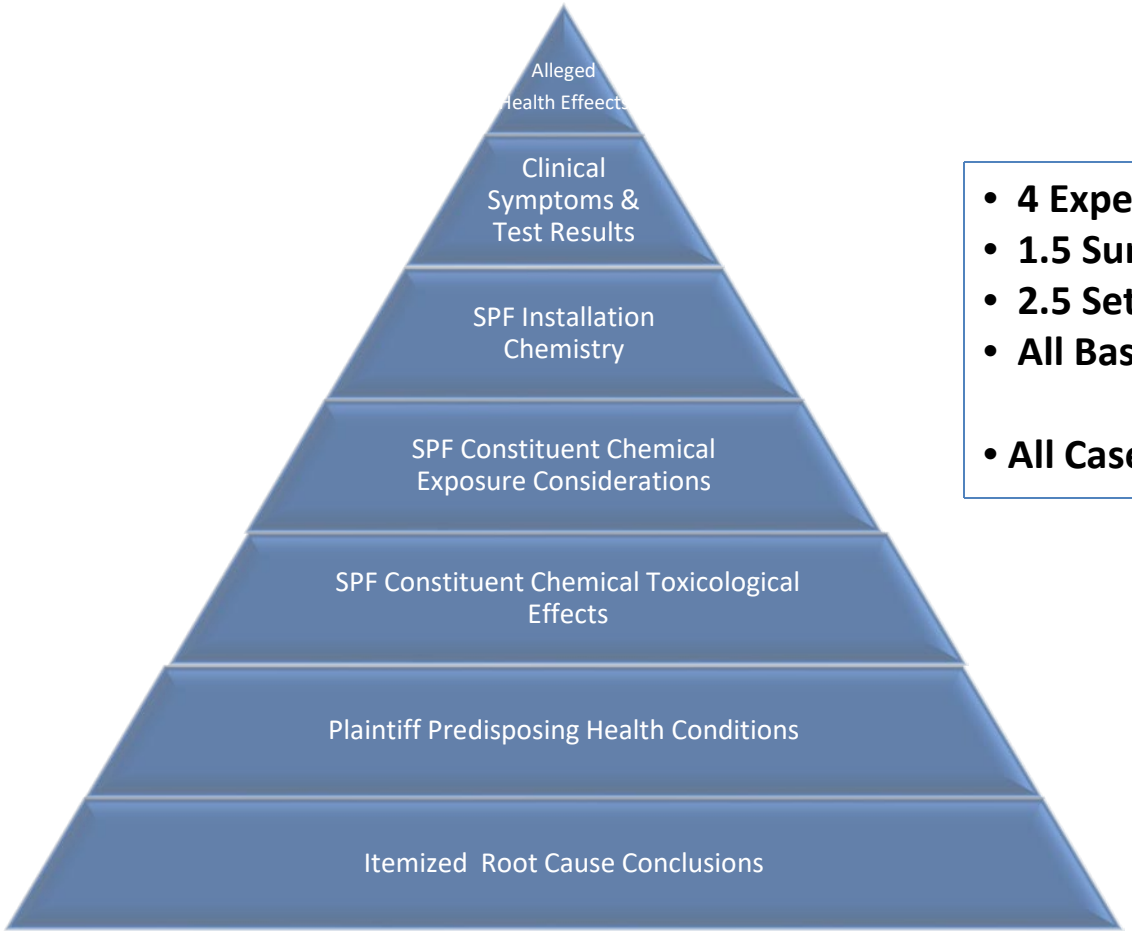
3. **How many of you have some background in chemistry?**

Toxicology – The Regulatory Science of Poisons



SPF Chemistry Lawsuit Experiences

Case-Specific *Toxicological Root Cause Analysis Elements*



- **4 Expert Witness Cases - Defendants**
- **1.5 Summary Judgment Wins**
- **2.5 Settled Wins**
- **All Based Upon Detailed Chemistry Risk Assessments**
- **All Cases Started by Installation Complaint**

“Safe” – Dictionary Definitions

1. “free from harm or risk” – different?
2. “secure from threat or danger, harm, or loss”
3. “affording safety or security from danger, risk, or difficulty”
4. “not likely to take risks; cautious”
5. “*successful in reaching base in baseball without being put out*”

Historic Toxicology - Definitions

HAZARD – estimated/measured adverse effect from a chemical under specific conditions

TOXIC – deleterious to man &/or other organisms

POISON – any agent capable of producing a deleterious biological response (every known chemical)

RISK – probability an adverse effect will occur under specified conditions, influenced by

- Exposure amount, frequency, duration
- Exposure route (inhalation, ingestion, dermal)
- Effect severity/usage conditions

RISK = f (Hazard ● Exposure)

HAZARD ASSESSMENT (Chemical) – experimentally identify deleterious effects: Health, Environmental, Safety

RISK ASSESSMENT – characterization of potential adverse effects under specified usage and exposure conditions

- Identify hazards
- Evaluate exposure elements & conditions
- Eliminate or control the hazards

Paracelsus – The Father of Toxicology
(1493-1541)

"Alle Ding sind Gift, und nichts ohn Gift, allein die Dosis macht, das ein Ding kein Gift ist"

All things are poisons, and nothing is without poison; only the dose permits something not to be poisonous

"Substances considered toxic are harmless in small doses, and conversely, an ordinarily harmless substance can be deadly if over-consumed"

"'Poisons' were not necessarily something negative…poisons could have beneficial medical effects"
[*toxicology vs. pharmacology*]

The Dose Makes the Poison

Hazard Assessments *vs.* Risk Assessments

HAZARD of CONCERN	RISK MODIFICATION STRATEGIES	RESULTANT BENEFITS
• Medicines/Vaccines	Dosages, Frequency, Duration	Prevent/Cure Diseases
• Food Constituents Potatoes – *Arsenic/Bromine/Nickel* Mushrooms, Duck, Pears, Cauliflower - *Formaldehyde* Tea – *Fluoride*	Small concentrations, Vary Diet	Nutrition/Health
• Vehicle Fuel Flammability	Engineering Controls	Efficient Transportation
Product/Process Chemicals	Exposure Minimization Engineering Controls	Diverse Product Availability

All chemicals are hazardous, but prudent management & use can eliminate the risks

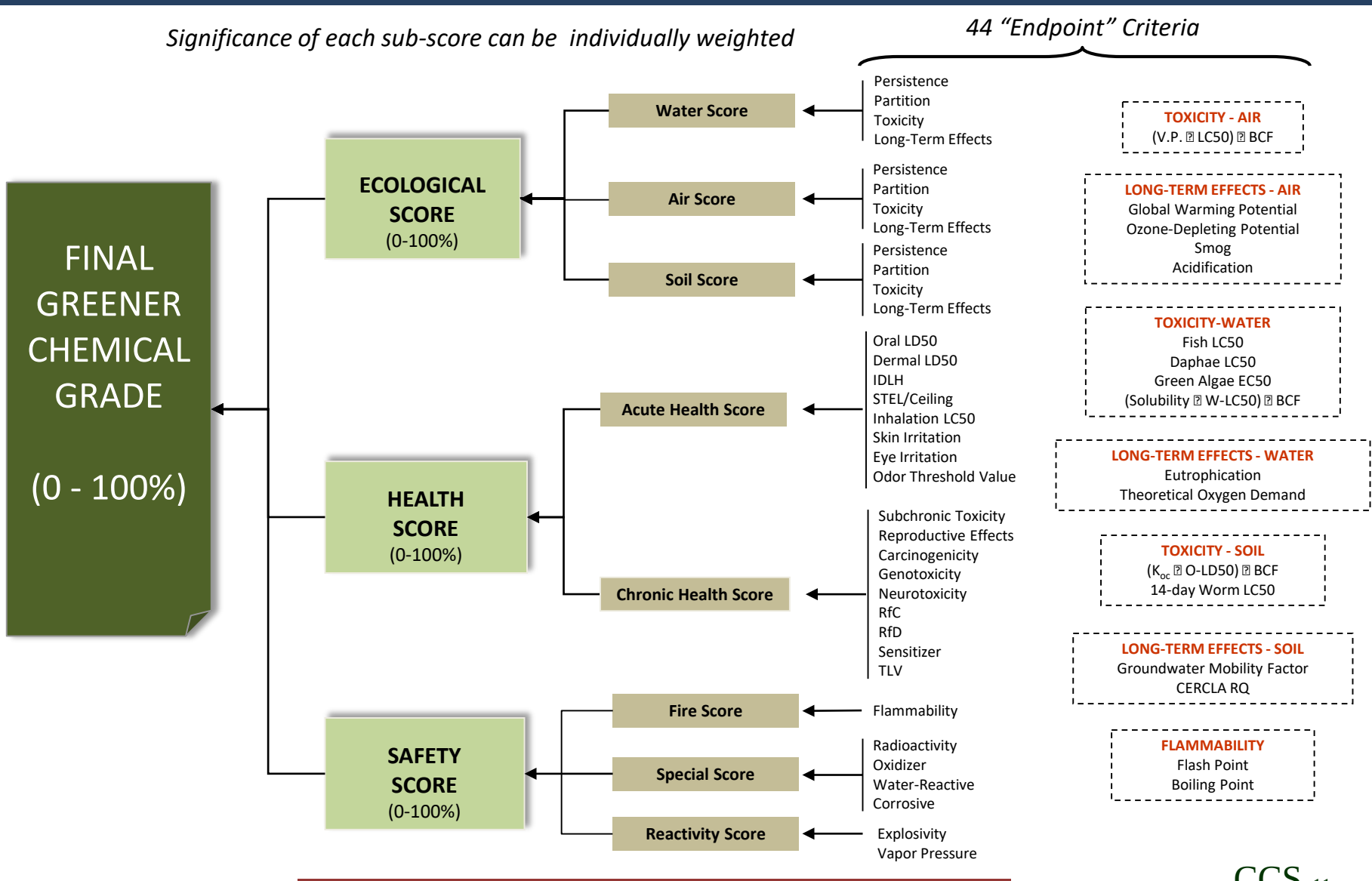
CCS Relational Chemical and Product Database (R-CPD) Statistics - 2018

Continuous Data Compilation Since 1985

≥ 80,000,000	Data Elements
280,000	Chemicals
>29,000	Chemicals with 44 EHS Endpoints
1,250	*Fracking Chemicals*
1,100	*Munition Chemicals*
1,000	*Cosmetic Chemicals*
200	*Spray Polyurethane Foam Chemicals*
➢1,500,000+	Product SDSs
> 10,000	Manufacturers
1,000	Public Data Sources
> 800	Chemical Regulatory Lists

"GREENER" CHEMICAL SCORING PROCESS

Chemicals – Products – Processes – Wastestreams



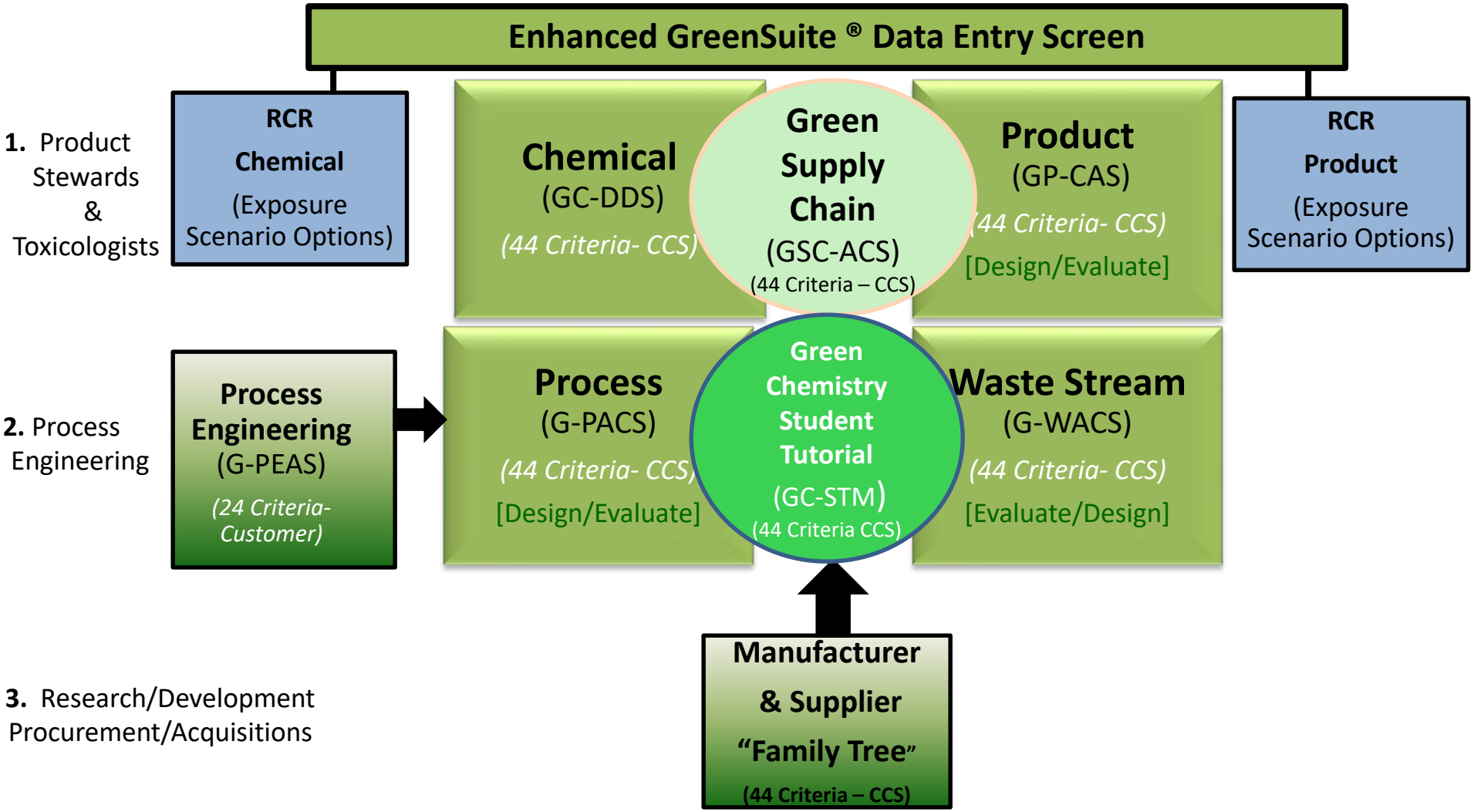
44 ENDPOINTS IN THE NSF/GCI/ANSI 355-2011 NATIONAL STANDARD

GreenSuite® Scoring Hierarchy Descriptors

Green Score	Alpha Score	Text Descriptor
97 - 100	A+	Highly Probable Non-Risk
93 - 96	A	Very Probable Non-Risk
90 - 92	A-	Probable Non-Risk
87 - 89	B+	Reasonable Non-Risk
83 - 86	B	Possible Non-Risk
80 - 82	B-	Cautious Non-Risk
77 - 79	C+	Minimal Risk
73 - 76	C	Slight Risk
70 – 72	C-	Moderate Risk
65 – 69	D	Serious Risk
< 65	F	Extreme Risk

Enhanced GreenSuite®

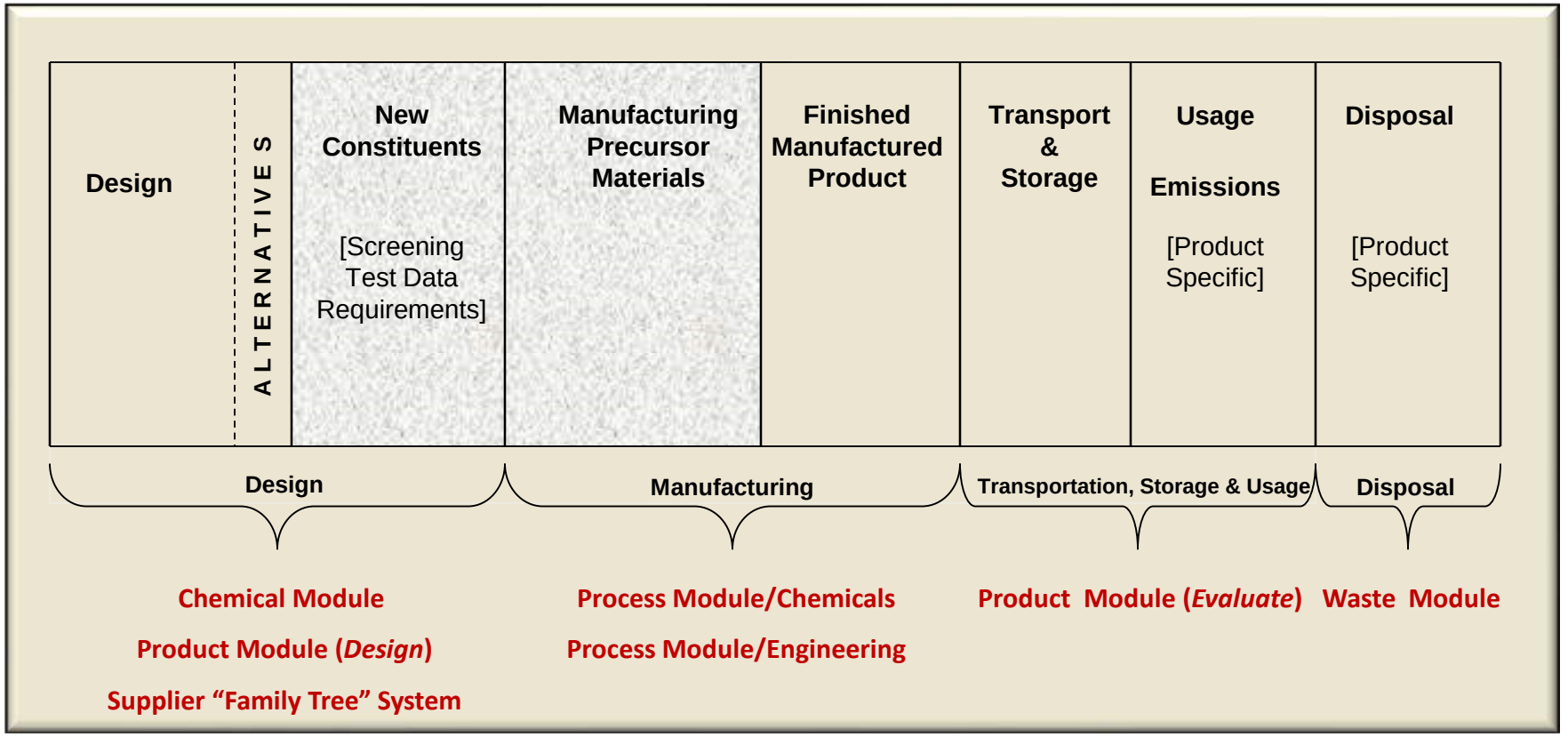
"One tool cannot do it all!"



[10 Optional Hazard & Risk Assessments]

GreenSuite®

Lifecycle Alternative Assessments

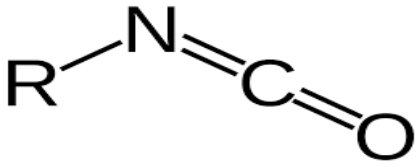


Spray Polyurethane Foam (SPF) Chemistry

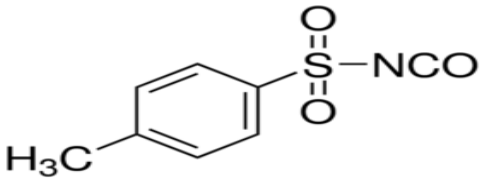
Side A	+	Side B	----->	Curing SPF	----->	Cured SPF "Article"
Isocyanate Blend	+	Polyol Blend	---->	SPF	---->	SPF
Reacts 100% Isocyanate chemicals		Polyols React 100% Polyols (20-70%) Amine/Metal Catalysts (0.1-5%) Flame Retardants, Reactive (5-8%) Flame Retardants, Nonreactive (10-30%) Surfactants (<1%) Blowing Agent, Reactive – Water (17-20%) Blowing Agent, Nonreactive (8-14%) Antimicrobial (<0.5%)		SPF (+ CO_2) SPF (Solid) – No Free Isocyanate Residual Glycols – V. Low VP Amine/Metal Catalysts (Intact) – Low VP Bound 100% to SPF Flame Retardants, Nonreactive (Intact) – V. Low VP Surfactants (Intact) – Extremely Low VP Blowing Agent Reacts 100% to Form CO_2 Blowing Agent, Nonreactive (Intact) High VP Antimicrobial (Intact) – V. Low VP Urea – Low VP		SPF (+ CO_2) SPF (Solid) – No Free Isocyanate Amine/Metal Catalysts (Intact) – Low VP Bound 100% to SPF Flame Retardants, Nonreactive (Intact) – V. Low VP Surfactants (Intact) – Extremely Low VP Reacts 100% to Form CO_2 Blowing Agent, Nonreactive (Intact) High VP Antimicrobial (Intact) – V. Low VP

The cured SPF 'article' contains low residue levels of Catalysts, Nonreactive Flame Retardants, Surfactants, and Antimicrobials, but None of these readily evaporate due to their very low to extremely low Vapor Pressures (VP). If the Side B formulas contained a Nonreactive Blowing Agent, this material will evaporate quickly from the surface of the SPF due to its high VP (i.e., during the curing time), with the reminder locked within the matrix of the SPF. During the curing process, residual SPF constituent continue to react until the freeze – out temperature is reached as a result of heat dissipation.

Isocyanate Chemical Structures



Isocyanate Ion



P-toluenesulfonyl isocyanate
4083-64-1
Green Scores: 74 77 83 63

4,4'-Diphenylmethane diisocyanate (MSDI)
CAS #: 101-68-8
Green Scores: 65 59 51 85

Side A - Isocyanate GreenSuite® Hazard Assessment Comparisons

Chemical Name	CAS #	Green Grade	Ecological	Health	Safety
Hexamethylene diisocyanate	28182-81-2	89	84	87	97
P-Toluenesulfonyl isocyanate	4083-64-1	74	77	83	63
Polymethylene polyphenylisocyanate	9016-87-9	72	70	59	85
Methylene bisphenyl isocyanate	26447-40-5	68	59	60	85
Metheylene diphenyl diisocyanate	101-68-8	65	59	51	85
Toluene-2-diisocyanate	584-84-9	64	69	47	77
Isophorone diisocyanate	4098-71-9	63	65	54	72

Primary Isocyanate Health Hazards

(Two Lowest Health Scores: TDI = 47 & MDI = 51)

- **Acute Health Hazards** (Scores = 30 & 30)
  - IDLH = 0 & 0
  - STEL/Ceiling = 0 & 5
  - Inhal LC5O = 2 & 7
  - Skin Irrit. = 25 & 80
  - Eye Irrit. = 0 & 25
- **Chronic Health Hazards** (Scores = 64 & 73)
  - Carcinogencity = 50 & 90
  - Sensitizer = 0 & 0
  - TLV = 0 & 9

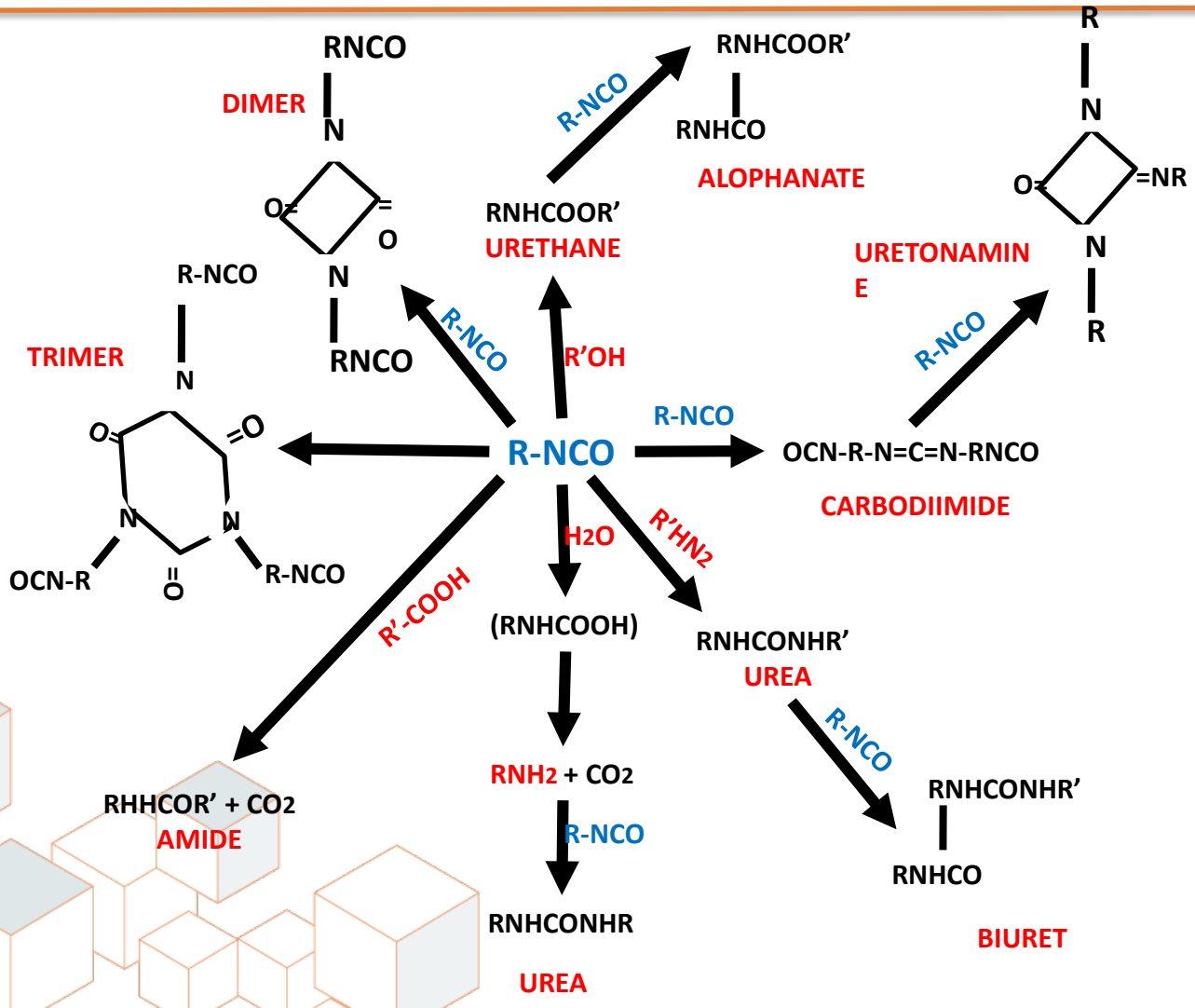
Scores < 65 in Red

CPI recommends full personal protective equipment to prevent skin, eye & inhalation exposure

Side A - Isocyanate GreenSuite® Hazard Assessment Comparisons, Vapor Pressure & Density

Chemical Name	CAS #	Green Grade	Ecological	Health	Safety	Vapor Press. (mmHg)	Density (g/cm3)
Water/Air	7732-18-5/---	100/---	100/---	100/---	100/---	23.8	1.225 E-3
Hexamethylene diisocyanate	28182-81-2	89	84	87	97	1 E-3	1.14
P-Toluenesulfonyl isocyanate	4083-64-1	74	77	83	63	9.44 E-5	1.29
Polymethylene polyphenylisocyanate	9016-87-9	72	70	59	85	5.4 E-13	1.23
Methylene bisphenyl isocyanate	26447-40-5	68	59	60	85	4.8 E-5	1.24
Metheylene diphenyl diisocyanate	101-68-8	65	59	51	85	1.89 E-4	1.23
Toluene-2-diisocyanate	584-84-9	64	69	47	77	2.38 E-2	1.22
Isophorone diisocyanate	4098-71-9	63	65	54	72	3.0 E-4	1.06

Isocyanate Chemical Reactions in Polyurethanes



Side B – Polyol Blend GreenSuite® Hazard Assessment Comparisons (15-30 CAS #s)

Chemicals	Conc. (%)	Green Grade	Ecological	Health	Safety
Blowing, Reactive (1)	1	100	100	100	100
Blowing, Nonreactive (1)	9	86	77	91	92
Polyether Polyols (3)	0.8-15.2	85-88	75-84	78-90	92
Polyol, Sucrose (1)	6	85	74	89	92
Polyol, Aromatic (1)	39	86	78	89	92
Flame Retardant (2)	6-17	87	77	91	92
Surfactant (3)	0.03-4.8	79-86	74-81	70-86	92
Catalyst, Metal (6)	0.002-5.6	37,77-86	53, 62,76-78	26, 61, 84-89	30, 83-92
Catalyst, Amine (7)	0.2-0.8	71-83	68-73	50, 55, 81-88	83-92

Curing/Cured SPF Constituent Risk Assessments (11/9 CAS #s)

Constituent	Conc. (%)	Ranking	Green Grade	Ecological	Health	Safety
Polyurethane Foam (SPF)	78	1	95	95	92	97
Polyol-1	0.04	2	89	83	86	97
Surfactant	0.36	3	88	78	89	97
Catalyst, Metal	5	4	88	77	91	97
Flame Retardant, NR	4	5	88	76	91	97
Blowing Agent	3.1	6	86	73	85	100
Catalyst, Amine-1	1	7	83	78	74	97
Reaction Product-1	7.3	8	82	69	77	100
Catalyst, Amine-2	1	9	81	68	86	88
Catalyst, Amine-3	0.05	10	77	66	84	82
Catalyst, Amine-4	0.2	11	72	74	**52**	90

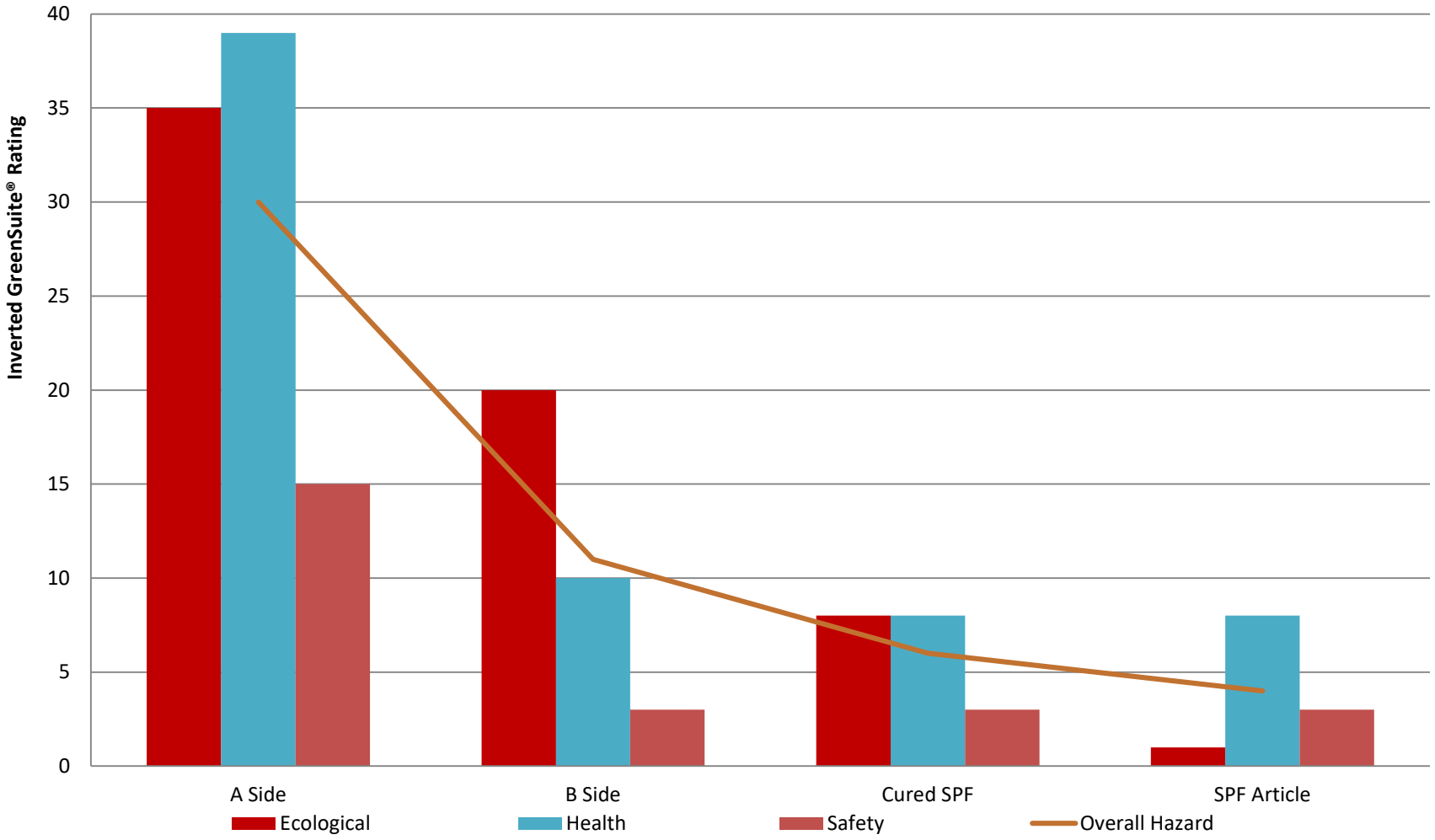
CPI Published SPF Air Sampling Test Results

		Med Dens/HP [CC] (ppm)				Low Dens/HP [OC] (ppm)			Low Press Kit [CC] (ppm)		
ACH	Time	A Side	B Side			A Side	B Side		A Side	B Side	
		MDI (2)	Am. Cat.	TCPP	HFC	MDI (2)	Am. Cat.	TCPP	MDI (2)	Am. Cat.	TCPP
~10	Applic	0.025	8.0	0.32	300	0.014	1.0	0.15	0.0002	1.8	0.04
	1 hr	0	0.02	0.003	1.0	0	0.065	0.0017	0	0.01	0.001
	2 hr	0	0.005	0.0013	0.5	0	0.05	0.0015	0	0.003	0.0013
~ 2	3 hr										
	4 hr	0	0.007	0.001	0.9	0	0.07	0.0018	0	0.005	0.0017
	8 hr	--	0.006	0.001	0.8	--	0.09	0.0023	--	0.006	0.002
	12 hr	--	0.005	0.001	0.5	--	0.08	0.002	--	0.014	0.0015

MDI OEL = 0.005 ppm; Amine Cat. OEL = 0.05 ppm; TCPP No OEL; HFC OEL = 300-1000 ppm

In 5 lawsuits: MDI never detected; common VOCs & surfactants ID; TCPP very low levels in 1/8 poor tests

Decreasing SPF Systems Relative Risk



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Reacts 100%		Polyols React 100% Amine/Metal Catalysts 50% Dilution Flame Retard., Nonreactive 50% Dilution Blowing Agent, Nonreactive 50% Dilution Antimicrobial 50% Dilution		SPF (+ CO_2) SPF (Solid) – No Free Isocyanate Residual Glycols – V. Low VP Amine/Metal Catalysts (Intact) – Low VP Bound 100% to SPF Flame Retard., Nonreactive V. Low VP Surfactants (Intact) – Extremely Low VP Blowing Agent, Nonreactive (Intact) High VP Antimicrobial (Intact) – V. Low VP Urea – Low VP		SPF (+ CO_2) SPF (Solid) – No Free Isocyanate Amine/Metal Catalysts (Intact) – Low VP Bound 100% to SPF Flame Retard., Nonreactive (Intact) – V. Low VP Surfactants (Intact) – Extremely Low VP Blowing Agent, Nonreactive (Intact) High VP Antimicrobial (Intact) – V. Low VP

- **Full PPE required during installation**
- **All occupants vacated during & 24-48 hours after**
- **Ventilate to outside during installation**

- **Maintain vacancy for 24-48 hours after install**
- **Aggressively ventilate to outside during curing**

- Document thorough final project inspection
- Walk through with customer

OSHA Hazard Communication Standard (HazCom)

- **Aligned with UN Global Harmonization System (GHS) 2012**
- **Classified Potential Chemical Hazards, including A & B Side constituents**
- **Employee Communication of Potential Chemical Hazards & Protections**
  - *Written Hazard Communication Plan (WHCP)*
  - *List of Chemical Hazards Present*
  - *Container Labeling – Workplace & Shipped*
  - *Safety Data Sheets (SDSs)*
  - *Employee Training Program*

OSHA Safety Data Sheet (SDS) Elements

1. Product Identification – Chemical/Mixture
2. Hazard(s) Identification
3. Product Hazardous Composition
4. First Aid Measures
5. Fire Fighting Procedures
6. Accident Release Measures
7. Handling and Storage
8. Exposure Controls/PPE
9. Physical/Chemical Properties
10. Stability/Reactivity
11. Toxicological Information
12. Ecological
13. Disposal Consideration
14. Transportation Information
15. Regulatory Information
16. Other Information (Prep Date/Last Revision)

Exposure Prevention Strategies

- **OSHA Hazard Communication required employee training**
  - Written Hazard Communication Program
  - Product & chemical Safety Data Sheet (SDS) review
  - Product hazard awareness training
  - Container labeling
  - Exposure prevention strategies & equipment
  - Personal Protective Equipment (PPE) requirements
- **Installer certification with SPF manufacturer**
- **Worksite preparation procedures**
  - Ventilation during & 24-48 hours after installation
  - Airflow barriers & site protection coverings
  - Restricted access placards – outside, inside
- **Building vacancy 24-48 hours post installation**
  - Humans & pets
  - Written & signed documentation of this requirement

Toxic Substances Control Act Amendments - Overview

- **New Risk-Based Safety Standard**
  - ► Must Consider Risks to Susceptible "Highly" Exposed Populations.

- **Risk Assessment Priorities**
  - ► High = unreasonable risk due to potential chemical hazard and route of exposure
  - ► Low = the chemical use does not meet high-priority standard.

- **High Priority Designation Triggers Assessment Completion Deadline**

- **Chemical Assessment Prioritization (11/29/2016) – First 10 Chemical Risk Assessments**
  - ► 1, 4 Dioxane
  - ► 1, Bromopropane
  - ► Asbestos
  - ► Carbon Tetrachloride
  - ► Cyclic Aliphatic Bromide Cluster
  - ► Methylene Chloride
  - ► N-Methylpyrrolidone
  - ► Pigment Violet 29
  - ► Tetrachloethylene=Perchlroethylene
  - ► Tetrichloroethylene

- **Scoping Document / Chemical Within 6 Months**
  - ► Hazards
  - ► Susceptible Subpopulations
  - ► Conditions of Use
  - ► Exposures

- **3-Year Risk Assessment Completion Deadline**

- **If Unreasonable Risk, 2-Year Mitigation Deadline**

- **By 12/31/2019 - 20 Chemical Risk Assessment Continuously Ongoing**

Safe SPF - Conclusions

- **SPF is safe for consumers, but potentially hazardous for workers**
  - SPF chemistry protects the customer when properly installed
  - PPE and best business practices keep workers safe from SPF constituents

- A **Side is very hazardous (Health Scores = 47-60) – Risk is controllable**
  - Full body PPE & air supply
  - Rapidly reactive – binds to anything/everything
  - Heavier than air – settles quickly
  - Isocyanates undetectable within < 1 hour; don't evaporate
  - Isocyanates not in cured SPF

- B **Side is much less hazardous (Health Scores mostly 70-100)**
  - Protected by full body PPE & air supply
  - Zero to minimal residues in cured SPF – diluted 50%
  - Predominant polyols minimal hazards, mostly/entirely reacted

- **SPF system initial hazards essentially gone in properly cured SPF**
  - Isocyanate 100% reacted
  - B Side constituents diluted 50%
  - Proper chemistry during installation & curing is key

Safe SPF - Recommendations

- **Manufacturers develop SPF complete system risk assessments**
  - Evaluate A Side, B Side, Curing SPF, & Cured SPF
  - Use proprietary reports for internal constituent alternative assessments & sales literature
  - Provide nonproprietary reports to distributors & installers
  - Train product development chemists regarding "green" chemistry, i.e., hazards & risks
  - Add "green" chemistry SPF system awareness to installer certification program
  - Distribute SDSs for entire SPF system – A Side, B Side, Curing SPF & Cured SPF – to cusotmers
  - Maintain liability insurance in case of lawsuits

- **Installers request manufacturer nonproprietary SPF system risk assessment reports & SDSs**
  - **Reject potential customers with asthma, known chemical sensitivities, or COPD**
  - Train & test installers & sales staff regarding constituent hazards & formulation risks
  - Maintain SDSs for all SPF system components
  - Inspect/grade/evaluate completed SPF projects - with pictures
  - Maintain detailed records for each SPF project – specific process, issues, equipment
  - Annually monitor installer health
  - Maintain liability insurance in case of lawsuits

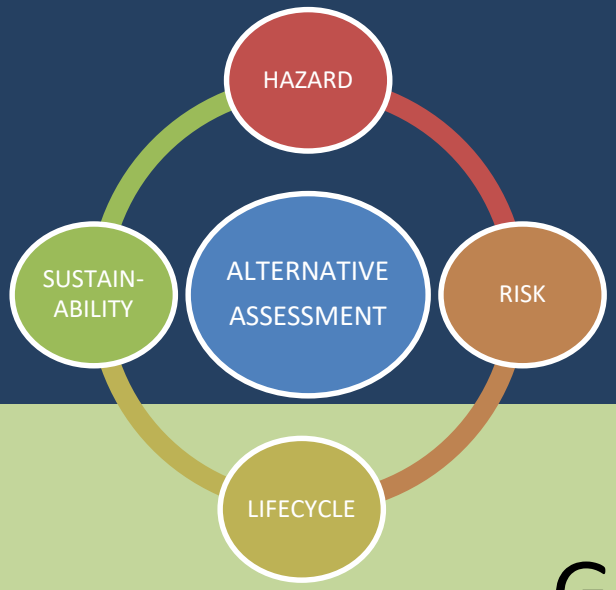
GreenSuite® SPF Hazard & Risk Assessments – Free Webinar

Wednesday, February 21, 2018 1:30 – 3:00 pm(ET)

- **SPF Manufacturers, Distributors , Installers, & Attorneys**
- **Management, Sales Staff , Legal & Employee Hazard & Risk Awareness**
- **SPF Chemists Converted to "Green" Chemists**
- **Sales Staff Proprietary Product Awareness with Nonproprietary Report Resource**
- **Installer increased awareness improves customer satisfaction & Reduces Risks**
- **Management & Legal Awareness Improves Business & Minimizes Lawsuit Risks**
- **Demonstration – Quantitative Chemical Hazard Assessments in Seconds**
- **Demonstration – Quantitative SPF Formulation Risk Assessments in Seconds**

Pre-Registration = georgethompson@chemply.com

Or, See Me at the CCS Booth



Thank You

Questions/Comments to:

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