● The regulatory basis for dermal protection
● PPE labeling accuracy
  ● Signal word and PPE
  ● Inconsistent terminology
  ● Lack of performance standards
● Incorrect/outdated PPE information
● Possible approaches to address issues
  ● Stakeholders must rally for change
Label Language Basis

- 40 CFR 156 - Labeling Requirements for Pesticides and Devices
  - Signal words
  - PPE statements for agricultural “worker protection”

- A prescriptive approach for PPE requirements is based on risk assessment
History Lesson

- *EPA’s Guidance Manual for Selecting Protective Clothing for Agricultural Pesticides Operations* (1993); its FIFRA mandates:
  - Consistent policy for PPE
  - Specifying PPE performance data to be provided by a potential pesticide registrant
  - Reviewing PPE performance data submitted to the Agency
  - Developing a “standard” for PPE use and maintenance
History Lesson

- Personnel Protection Technology (PPT) Program was established within EPA’s Office of Research and Development

- Guidance Manual: **PPT is fundamental to the EPA’s regulatory and operational missions**
  - Must have state-of-the-art PPT information with which to develop, defend, and enforce its regulations
  - Must be able to transfer information to the field in agricultural worker training programs
  - In some cases, the fundamental data upon which to base worker protection regulations have not been generated.

*EPA’s Guidance Manual for Selecting Protective Clothing for Agricultural Pesticides Operations*
History Lesson

- **Guidance:**
  
  *to provide technical information and guidance to the OPP personnel who formulate PPE standards, decisions, and recommendations for persons who handle pesticides*

- Provides good, factual information
  
  *based on research available in 1993*

- **Little continuity or follow-through**

_{EPA’s Guidance Manual for Selecting Protective Clothing for Agricultural Pesticides Operations_}
Product Labeling Instructions

Recently updated
• Glove statements
• Respirator statements

Worker Protections Statements— future changes
• Waterproof
• Chemical-resistant

Ag versus Industrial/Commercial
Signal Words

*most severe*
for any of the five toxicity studies

“end-use product”

1. acute oral
2. acute dermal
3. acute inhalation
4. primary eye irritation
5. primary skin irritation

6th
dermal sensitization

4% or more of methanol

Source: EPA Training Document: *Pesticides: Regulating pesticides*
Example: WA Tree Fruit Labels
A. Shaw (Univ. of Maryland Eastern Shore)
data set 2012: n=128

- **Caution**
  - 9 Coverall LSS, LP
  - 1 Coverall SSS, SP
  - 74 LSS, LP

- **Warning**
  - 4 Coverall SSS, SP
  - 22 LSS, LP

- **Danger**
  - 3 Coverall LSS, LP
  - 3 Coverall SSS, SP
  - 4 LSS, LP

- **Danger-Poison**
  - 2 Coverall LSS, LP
  - 1 Coverall SSS, SP
  - 5 LSS, LP
• Some publications have incorrectly linked and recommended using the signal word to select PPE

• Need to evaluate our current outreach materials and update where appropriate
## Default Label Language Based on Acute Toxicity (40 CFR 156.212)

*Assess modifications based on risk assessment e.g., use pattern, incident data*

<table>
<thead>
<tr>
<th>Acute Toxicity Category</th>
<th>Worker Protection Statement - Required Dermal PPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toxicity Category IV</td>
<td>Based on Acute Dermal and Acute Dermal Irritation: LSS, LP</td>
</tr>
<tr>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>Toxicity Category III</td>
<td>Based on Acute Dermal and Acute Dermal Irritation: LSS, LP, gloves</td>
</tr>
<tr>
<td>Caution</td>
<td></td>
</tr>
<tr>
<td>Toxicity Category II</td>
<td>Based on Acute Dermal and Acute Dermal Irritation: Coveralls, SSS, SP, gloves, apron, headgear</td>
</tr>
<tr>
<td>Warning</td>
<td></td>
</tr>
<tr>
<td>Toxicity Category I</td>
<td>Acute Dermal and Acute Dermal Irritation: Coveralls, LSS, LP, gloves, apron, headgear</td>
</tr>
<tr>
<td>Danger</td>
<td></td>
</tr>
</tbody>
</table>

**Signal words are **ALSO** based on acute ORAL toxicity**

**Those with low dermal toxicity** may have moderate or high ORAL toxicity

**Garment basis:** two layers, not performance

Adapted text and image from EPA Label Review Manual Table 1 – C. Black
Today, I challenge you to find a label that requires chemical resistant coveralls.

The use pattern may necessitate that a person selects to wear them -- not the label.
Current Label Review Manual and Risk Assessment

- In the 1990’s, did not rely on performance standard for garments
  - Risk assessment based on two-layers for protection factor
  - Tiered approach used
  - No studies were conducted for other chemical-resistant PPE (aprons, headgear, coveralls/suits, or footwear)
- Basic studies were completed ONLY on gloves/solvents
- Today there are performance standards for garments.
- Needs to be new data on gloves.
Glove are their own Beast
## EPA Chemical Resistant Chart for Gloves

<table>
<thead>
<tr>
<th>Solvent Category</th>
<th>Barrier Laminate</th>
<th>Butyl Rubber ≥ 14 mils</th>
<th>Nitrile Rubber ≥ 14 mils</th>
<th>Neoprene ≥ 14 mils</th>
<th>Natural Rubber ≥ 14 mils*</th>
<th>Polyethylene</th>
<th>Polyvinyl Chloride (PVC) ≥ 14 mils</th>
<th>Viton ≥ 14 mils</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (dry and water-based)</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>B</td>
<td>High</td>
<td>High</td>
<td>Slight</td>
<td>Slight</td>
<td>None</td>
<td>Slight</td>
<td>Slight</td>
<td>Slight</td>
</tr>
<tr>
<td>C</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>D</td>
<td>High</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Slight</td>
</tr>
<tr>
<td>E</td>
<td>High</td>
<td>Slight</td>
<td>High</td>
<td>High</td>
<td>Slight</td>
<td>None</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>F</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Moderate</td>
<td>Slight</td>
<td>None</td>
<td>Slight</td>
<td>High</td>
</tr>
<tr>
<td>G</td>
<td>High</td>
<td>Slight</td>
<td>Slight</td>
<td>Slight</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>High</td>
</tr>
<tr>
<td>H</td>
<td>High</td>
<td>Slight</td>
<td>Slight</td>
<td>Slight</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>High</td>
</tr>
</tbody>
</table>

Easy to confuse “chemical resistance” for apron, headgear, and footwear with chart for gloves.
Gloves are KEY to protection
- hand and forearm identified as parts of the body that come into the most contact with pesticides (EPA)

Glove studies conducted in the 1980s were used to develop the Chemical Resistance Category Selection Chart for Gloves - funded by EPA

Published article (Schwope et al., 1992)
- recommendation to use carrier solvent as the basis for selecting glove type was a starting point
- “until more specific data from permeation testing with pesticide formulations become available”
Solvent breakthrough time continues to be used today as the sole basis for determining glove requirements.

- Not considered in the assessment
  - Pesticide toxicity
  - Typical contact time under normal use patterns
  - Glove dexterity and fit
  - Expense to purchase
Inconsistencies in the criteria used to determine the level of dermal protection provided by garments, gloves, aprons, headgear, and footwear result in PPE labeling statements and requirements that are confusing to applicators, educators, and regulators.
Terminology

PPE definitions published in 40 CFR 170.240 (EPA, 1992)

- **Work wear**
  - Long/short sleeved shirt and long/short pant

- **Personal Protective Equipment - dermal**
  - waterproof or chemical-resistant gloves
  - coveralls
  - chemical-resistant suits
  - chemical-resistant footwear
  - chemical-resistant aprons
  - chemical-resistant headgear
Work wear

- Could be exact same material as “coverall”
- Handler must clean (at home or Laundromat)

Coverall

- Could be very thin: spunbound and non woven
- Employer responsible they are cleaned
Terminology
PPE definitions published in 40 CFR 170.240 (EPA, 1992)

(4) “coveralls”
- loose-fitting, one- or two-piece garment, such as a cotton or cotton and polyester coverall, that covers, at a minimum, the entire body except head, hands, and feet. T
- labeling may specify that the coveralls be worn over another layer of clothing.

(2) “waterproof”
- material that allows no measurable movement of water or aqueous solutions through the material during use.

(1) “chemical-resistant”
- material that allows no measurable movement of the pesticide being used through the material during use.

(3) “chemical-resistant suit”
- loose-fitting, one- or two-piece chemical-resistant garment that covers, at a minimum, the entire body except head, hands, and feet.
Chemical-resistant

- In very general terms, means that a textile or glove material will resist penetration and/or permeation of chemicals
- Requires testing of the gloves, headgear, apron, footwear, coveralls against the the liquid
  - Each formulated product

- EPA requirement: No measureable movement

Not detected
1.21 µg/cm²
12.06 µg/cm²
161.89 µg/cm²
Totally Impractical

- EPA’s proposed WPS definition for chemical-resistant personal protective equipment
  - “it must be made of material that the manufacturer has declared, in writing, to be chemical-resistant” (EPA, 2014)

- Burden of responsibility has been shifted to the purchaser or user, who is expected to test the clothing against the chemical before using

- Performance standards could address this need for products that require more than basic work wear
## Comparison of signal words and PPE requirements

And we wonder why applicators are confused – Label clarity and education is the answer

<table>
<thead>
<tr>
<th>Signal Word</th>
<th>Garment</th>
<th>Glove Category (solvent)</th>
<th>Footwear</th>
<th>Add for Tox I &amp; II Headgear</th>
<th>Add for Tox I &amp; II Apron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caution</td>
<td>LSS, LP</td>
<td>G</td>
<td>Shoes plus socks</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Caution</td>
<td>Coveralls, LSS, LP</td>
<td>A</td>
<td>Chem Resist Footwear, S+S</td>
<td>Chem Resist Headgear</td>
<td>Chem Resist Apron</td>
</tr>
<tr>
<td>Caution</td>
<td>Coveralls, SSS, SP</td>
<td>H</td>
<td>Chem Resist Footwear, S+S</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Danger</td>
<td>LSS, LP</td>
<td>A</td>
<td>Shoes plus socks</td>
<td>No</td>
<td>Chem Resist Apron</td>
</tr>
</tbody>
</table>
Caution-labeled Product

Personal Protective Equipment (PPE)
Some materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category G on an EPA chemical-resistant category selection chart.

Mixers, loaders, applicators and other handlers must wear:
- Long-sleeved shirt and long pants
- Chemical-resistant gloves such as barrier laminate or Viton > 14 mils
- Shoes plus socks

A mix of LEAST and MOST
Personal Protective Equipment (PPE)

Some materials that are chemical-resistant to this product are polyethylene and polyvinylchloride. If you want more options, follow the instructions for category A on an EPA chemical-resistant category selection chart.

Mixers, loaders, applicators and other handlers must wear:

- Coverall over long-sleeved shirt and long pants
- Chemical-resistant gloves
- Chemical-resistant footwear plus socks
- Chemical-resistant headgear (If overhead exposure)
- A chemical-resistant apron when mixing/loading, cleaning up spills, or cleaning equipment, or otherwise exposed to the concentrate.

Gloves LEAST; others MOST
Personal Protective Equipment (PPE)
Some materials that are chemical-resistant to this product are **barrier laminate** or **viton**. For more information, follow instructions in Supplement Three of PR Notice 93-7. If you want more options, follow the instructions for **category H** on an EPA chemical resistance category selections chart.

Loaders, applicators and all other handlers must wear:
- Coveralls over long-sleeved shirt and long pants
- **Chemical-resistant gloves**
- **Chemical-resistant footwear** plus socks

Granular with an H – petroleum distillates intentional or an error?
Danger-labeled Herbicide

Corrosive. Causes irreversible eye damage. Harmful if swallowed. Do not get in eyes or on clothing.

Personal Protective Equipment (PPE)
Some materials that are chemical-resistant to this product are barrier laminate, nitrile rubber, neoprene rubber, or viton. If you want more options, follow the instructions for category A on an EPA chemical-resistant category selection chart.

All mixers, loaders, applicators, flaggers, and other handlers must wear:
- Long-sleeved shirt and long pants
- Shoes and socks
- Protective eyewear (goggles or face shield)
- Chemical-resistant gloves, when applying with any handheld nozzle or equipment, mixing or loading, cleaning up spills or equipment, or otherwise exposed to the concentrate.
- Chemical-resistant apron when applying, mixing/loading, cleaning up spills, or cleaning equipment, or otherwise exposed to the concentrate.
Gloves can be waterproof (A), but hats, aprons, and footwear must be chemical resistant.
Wear coveralls over short sleeved shirt and short pants, socks, **chemical resistant footwear**, **protective eyewear** (goggles, face shield, safety glasses) and **chemical resistant gloves** (barrier laminate or viton, selection category G).
Two Examples of Inaccurate Outreach Materials
Gloves
Always wear unlined, elbow-length chemical-resistant gloves when handling pesticides. The elbow-length protects your wrists and prevents pesticides from running down your sleeves into your gloves.

Glove materials include:
- **Natural rubber (latex)** – only effective for dry formulations. Relatively Permeable
- **Nitrile** – good protection for both dry and liquid pesticides. Moderately Permeable
- **Butyl** – good protection for both dry and liquid pesticides
- **Neoprene** – good protection for both dry and liquid pesticides. Not recommended for fumigants.
- Polyethylene
- Polyvinylchloride (PVC)
- Barrier laminate like 4H® and Silver Shield®. Relatively impermeable
### Characteristics of some commonly used pesticide coveralls
(Consult manufacturers for more information)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tempro®</td>
<td>IV (none)</td>
<td></td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>LOW</td>
</tr>
<tr>
<td>ProShield2®</td>
<td>I</td>
<td>III</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>LOW</td>
</tr>
<tr>
<td>Tyvek®</td>
<td>I</td>
<td>III</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>LOW</td>
</tr>
<tr>
<td>Tyvek® QC/ sewn seams</td>
<td>I</td>
<td>II</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>LOW</td>
</tr>
<tr>
<td>Tyvek® QC / sealed seams</td>
<td>I</td>
<td>II</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>Moderate</td>
</tr>
<tr>
<td>Kleenguard® LP</td>
<td>I</td>
<td>III</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>LOW</td>
</tr>
<tr>
<td>Tychem® SL/surged seams</td>
<td>I</td>
<td>I</td>
<td>NO</td>
<td>YES</td>
<td>NO</td>
<td>Moderate</td>
</tr>
<tr>
<td>Tychem® SL / sealed seams</td>
<td>I</td>
<td>I</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>HIGH</td>
</tr>
<tr>
<td>PVC coverall</td>
<td>I</td>
<td>I</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>HIGH</td>
</tr>
<tr>
<td>PVC suit</td>
<td>I</td>
<td>I</td>
<td>YES</td>
<td>YES</td>
<td>NO</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

*Protection Class is determined by the “Signal Word” on the pesticide label:
Class I = Signal words “DANGER” or “DANGER/ POISON” (highly toxic)
Class II = Signal word “WARNING” (toxic)
Class III = Signal word “CAUTION” (less toxic)
Class IV = Signal word “CAUTION” (least toxic)
Footnote on web entry:
Due to the thousands of pesticide formulations available today, it’s impossible to determine if a particular garment protects against a specific chemical. Therefore, we recommend testing the clothing against the chemical before using.
PPE Label Statements

- Primary means for communicating risk mitigation for those supervising or handling pesticide products

- **Must be clear, concise, and consistent across labels.**

- Confusing, inaccurate, and/or general PPE statements on **negate the time, effort, and resources expended in conducting very expensive exposure studies, risk assessment, risk mitigation, and training**
  - pesticide labels
  - outreach materials
  - online PPE marketplace
EPA’s, SFIREG & Industry’s Role

- Review processes, science, and information management to more clearly communicate what PPE is required to protect pesticide handlers.

- Initiate or support necessary research to improve knowledge base behind the decision making.

- Revise or develop new guidance based on updated findings
SLA’s and PSEPs

- Become more aware of the underlying issues related to dermal protection
- Revise presentations and manuals
  - Shift in available chemistries/toxicities
- Engage in the dialogue to improve clarity, consistency, and communication
- Engage with the market to ensure appropriate PPE is available
Worker Protection Standard should address the underlying factors that serve as the foundation for assigning PPE.

1993 PPE guidance: “PPT is fundamental to the EPA’s regulatory and operational missions” and “EPA must have state-of-the-art PPT information with which to develop, defend, and enforce its regulations”

Assigning level of protection – WHEN NEEDED -- in accordance with performance standards, is essential and provides consistent, defensible PPE requirements
Based on performance, develop consistent levels of protection for

- Garments and headgear
- Footwear
- Gloves

Clarify the quantification of terms such as chemical-resistant and waterproof.

Descriptions would no longer be necessary if the level of performance is included in the standard
- **Simplify glove selection**
  Where applicable, disposable gloves could be used to improve dexterity, reduce cost, and provide a readily available option.

- **Simplify PPE label statements**
  The information about PPE levels can easily be included as a table with a consistent format.
A Call for Clear and Accurate Communication about PPE for Dermal Protection for Pesticide Handlers

Anugrah Shaw, Carol A. Black, Courtney Harned

Abstract

Current terminology and the process used for assigning personal protective equipment (PPE) for dermal protection affect the quality and accuracy of PPE labeling and outreach resources that pesticide handlers and their employers rely on. The PPE statements must be clear, concise, and consistent across labels since they are the primary means for communicating risk mitigation for those supervising or handling pesticide products. Confusing, inaccurate, and/or general PPE statements on pesticide labels or outreach materials negate the time, effort, and resources expended in conducting exposure studies, risk assessment, risk mitigation, and training. Throughout this document, examples are provided to illustrate common shortcomings in PPE labeling and to demonstrate the need for EPA to review its processes, science, and information management to more clearly communicate what PPE is required to protect pesticide handlers. By engaging in a dialogue and making necessary changes, EPA can provide guidance for registrants to label their products, for educators and regulators to develop outreach materials, and for employers to purchase PPE that protects their workforce from pesticide exposure.