

A Call for Clear and Accurate Communication about PPE for Dermal Protection for Pesticide Handlers

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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.

Keywords: personal protective equipment, pesticide handlers, dermal protection, pesticide labels

Introduction

Safe and judicious use of pesticides is required to maximize benefits and minimize risks. The U.S. Environmental Protection Agency (EPA)'s Labeling Requirements for Pesticides and Devices (40 CFR 156) require that pesticide products sold for agricultural use include precautionary label statements addressing dermal protection – in particular, personal protective equipment (PPE) requirements – to ensure the health and safety of pesticide handlers (mixers, loaders, applicators, or others who use pesticides). A prescriptive approach for PPE requirements is based on risk assessment. Pesticide product labels must have clear, concise, and consistent PPE statements that are based on recent scientific advances. Handlers and their employers must be able to understand and follow the label statements in order to take necessary risk mitigation measures. An analysis of PPE information by Shaw and Harned (2013) on pesticide product labels revealed incongruent requirements for different parts of the body. For example, a label may require a long-sleeved shirt and long pants for whole-body protection and Viton® or barrier laminate gloves for hand protection. Furthermore, a cursory review of online resources revealed that considerable information published by educators, distributors, and state departments of agriculture on PPE selection, use, care, and maintenance is outdated or simply incorrect.

Discussions with stakeholders (e.g., pesticide handlers, trainers, risk assessors,

members of the crop protection industry, PPE industry representatives, members of standards development organizations, researchers, and policymakers) in the United States and other countries have allowed the authors to take a critical look at the issues related to selection and use of PPE through various lenses.

This paper presents several important issues and processes that affect the quality and accuracy of PPE information on labels. It goes on to offer possible approaches for addressing concerns, especially with labeling language. In particular, the paper discusses the relation of the signal word to PPE, inconsistent PPE terminology, the lack of PPE performance standards, and EPA's process for assigning PPE. Another issue discussed is incorrect and outdated PPE information available through the Internet. Several examples are provided for reference.

The Pesticide Product Label: The Signal Word, Dermal Protection Requirements, and the Process for Assigning PPE

Information on the product label submitted by the registrant is approved by EPA as part of an extensive review process. This information includes the signal word as well as dermal protection requirements. The following sections discuss interpretation of signal words and some PPE label concerns that stem from the process of assigning PPE.

Signal Word

A training document on the EPA website explains:

Acute toxicity studies examine a product's toxicity as it relates to six different types of exposure: acute oral, **acute dermal**, acute inhalation, primary eye irritation, **primary skin irritation**, and **dermal sensitization**. The product is assigned a toxicity category (I–IV) for each type of exposure based on the results of five of the six studies. (The sixth study, for dermal sensitization, evaluates the potential for allergic contact dermatitis. Its results are either positive or negative and do not affect the signal word.) A product's signal word is determined by the most severe toxicity category assigned any of the five acute toxicity studies, or the presence of methanol in concentrations of 4 percent or more. (EPA, 2014b; boldface type added by authors)

It is important to note that the signal word on a pesticide product label is based on the acute toxicity of the end-use product, **not** just the active ingredient. Furthermore, since the signal word on the label is based on other factors besides dermal toxicity and skin irritation, it should not be used as a reference for resources and materials that discuss PPE. Unfortunately, the signal word has sometimes been used out of context in resource materials (see examples below). As a result, some publications have incorrectly recommended using the signal word to select PPE.

Dermal Protection Requirements: A Historical Perspective

The introduction of EPA's *Guidance Manual for Selecting Protective Clothing for Agricultural Pesticides Operations* (1993) provides an excellent overview of the roles and responsibilities of EPA's Office of Pesticide Programs (OPP), as well as a plan of action to fulfill its mandates as outlined by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA; EPA, 1993). Section 1.1.3 of the guidance manual includes

nine bullets outlining these responsibilities mandated by FIFRA. The first bullet addresses development of a “consistent policy for PPE.” Other responsibilities include “specifying PPE performance data to be provided by a potential pesticide registrant,” “reviewing PPE performance data submitted to the Agency,” and “developing a standard for PPE use and maintenance” (EPA, 1993).

In the mid-1980s, the Personnel Protection Technology (PPT) Program was established within EPA’s Office of Research and Development. Section 1.1.4 of the EPA guidance manual states, “PPT is fundamental to the EPA’s regulatory and operational missions.” The section goes on to explain:

EPA must have state-of-the-art PPT information with which to develop, defend, and enforce its regulations. In particular, the Office of Pesticides and Toxic Substances must be able to assess petitions for registration of new pesticides and pre-manufacture notifications for new chemicals. Furthermore, OPP 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, 1993)

The primary purpose of the guidance manual was “to provide technical information and guidance to the OPP personnel who formulate PPE standards, decisions, and recommendations for persons who handle pesticides” (EPA, 1993). The remainder of the manual provides good, factual information based on research available in 1993. However, two decades later, there has been little continuity or follow-through in addressing the goals and responsibilities outlined in the introduction of the manual.

The Process for Assigning PPE

For agricultural (and some industrial/commercial) use products, the review process determines what PPE statements to include in the product labeling. Table 1 from EPA’s *Label Review Manual*, Chapter 10 (LRM; see Table 1 below), is used to assign default PPE requirements based on acute dermal toxicity and skin irritation potential of an end-use product (EPA, 2013). These default requirements are then compared to the PPE requirements determined from the health-based risk assessment. In most cases, the more stringent of the default PPE, based on the acute toxicity of the end-use product by route of entry, or the PPE derived from the risk assessment is the PPE that is required on an end-use product label. PPE can be added or removed based on systemic effects for dermal routes that depend on factors such as use pattern and incident data.

In the 1990s, EPA implemented a tiered approach that used the acute toxicity and irritation potential categories as the basis for PPE as outlined in the LRM table. For whole-body garments, an additional layer of clothing was used to provide greater protection (less pesticide penetrates through two layers). Note that for whole-body protection, a coverall worn over a long-sleeved shirt and long pants, not a chemical-resistant coverall, is specified for category I (Danger) for acute dermal toxicity or skin irritation potential. Table 1 footnotes address the concerns for differing toxicity issues of acute dermal toxicity versus skin irritation potential and selecting the more severe level. Gloves are required for all dermal toxicity categories (except category IV) for both dermal toxicity and skin irritation potential. A note explains that the specific type of

chemical-resistant glove is predicated on an additional decision matrix based on solvent.

The acute dermal toxicity or skin irritation potential does not play a role in the glove decision matrix. Chemical-resistant headgear for overhead spraying and a chemical-resistant apron for mixing and loading (not required if a chemical-resistant suit is worn) are assigned by EPA for products that are category I (Danger) or II (Warning) for dermal toxicity and/or skin irritation potential. For chemical-resistant whole- and partial-body garments (such as aprons, headgear, suits, and footwear), no criteria are provided to measure chemical resistance of the products and/or garments.

Table 1. Handler PPE for WPS products.

Route of Exposure	Toxicity Category by Route of Exposure of End-Use Product			
	I DANGER	II WARNING	III CAUTION	IV CAUTION
Dermal Toxicity or Skin Irritation Potential ¹	Coveralls worn over long-sleeved shirt and long pants	Coveralls worn over short-sleeved shirt and short pants	Long-sleeved shirt and long pants	Long-sleeved shirt and long pants
	Socks	Socks	Socks	Socks
	Chemical-resistant footwear	Chemical-resistant footwear	Shoes	Shoes
	Chemical-resistant gloves ²	Chemical-resistant gloves ²	Chemical-resistant gloves ²	No minimum

Source: *EPA Label Review Manual*, Chapter 10, Table 1. Table has been truncated to show only dermal requirements.

¹ If dermal toxicity and skin irritation toxicity categories are different, PPE shall be determined by the more severe toxicity category of the two. If dermal toxicity or skin irritation is category I or II, refer to Section 2 below [in LRM] to determine if additional PPE is required beyond that specified in Table 1.

² Refer to Section 3, Table 3 [in LRM] to determine the specific type of chemical-resistant glove.

In the 1990s when the tables were developed, no performance standards (e.g., standards developed by organizations such as the American Society for Testing and Materials and the International Standards Organization) were available to determine minimum performance of protective garments and accessories, including gloves. Information available at that time was used to determine the PPE requirement. The following are some observations regarding the approach used to determine protection in each of the PPE categories:

- A tiered approach based on garment type and/or layers was used for the whole-body garment. Operator exposure studies available at that time were used to calculate the protection factor for the second garment layer, the coverall.
- As stated in the EPA guidance manual, “Emphasis is placed on gloves since the hand and forearm have been identified as parts of the body that come into the most contact with pesticides in handling situations” (EPA, 1993). Glove studies conducted in the 1980s, funded by EPA, were used to develop the Chemical Resistance Category Selection Chart for Gloves found in LRM Table 3. This chart is referenced as a footnote in LRM Table 1 for selection of chemical-resistant gloves. The team

that conducted the studies published an article stating that the 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” (Schwope et al., 1992). However, use of solvent breakthrough time, originally expected to be a starting point, continues to be used today as the sole basis for determining glove requirements. Pesticide toxicity, glove dexterity, fit, and cost are not considered, nor is typical contact time under normal use patterns.

- No studies were conducted for other chemical-resistant PPE (aprons, headgear, coveralls/suits, or footwear).

Inconsistencies in the criteria used to determine the level of dermal protection provided by garments and accessories (aprons, gloves, headgear, and footwear) result in PPE labeling statements and requirements that are confusing to applicators, educators, and regulators.

Label Terminology

There are a number of concerns with pesticide labeling communication, the first of which is terminology. The language used in PPE label statements should be clear and concise so that it is easily understood by all stakeholders, especially pesticide users. Unambiguous terminology should be used consistently across the spectrum of products. Currently, labels have terms that are either not clearly defined or require interpretation by the user. Two examples are *chemical-resistant* and *waterproof*, technical terms that are used throughout EPA’s *Label Review Manual* and many informational resources. Given below are the PPE definitions published in 40 CFR 170.240 (EPA, 1992).

Personal protective equipment.

(a) Requirement. Any person who performs tasks as a pesticide handler shall use the clothing and personal protective equipment specified on the labeling for use of the product.

(b) Definition.

(1) Personal protective equipment (PPE) means devices and apparel that are worn to protect the body from contact with pesticides or pesticide residues, including, but not limited to, coveralls, **chemical-resistant** suits, **chemical-resistant** gloves, **chemical-resistant** footwear, respiratory protection devices, **chemical-resistant** aprons, **chemical-resistant** headgear, and protective eyewear.

(2) **Long-sleeved shirts, short-sleeved shirts, long pants, short pants, shoes, socks, and other items of work clothing are not considered personal protective equipment** for the purposes of this section and are not subject to the requirements of this section, although pesticide labeling may require that such work clothing be worn during some activities.

(c) Provision. When personal protective equipment is specified by the labeling of any pesticide for any handling activity, the **handler employer shall provide the appropriate personal protective equipment in clean and operating condition** to the handler.

(1) When “**chemical-resistant**” personal protective equipment is specified by the product labeling, it shall be made of material **that allows no measurable movement of the pesticide being used through the material** during use.

(2) When “**waterproof**” personal protective equipment is specified by the product labeling, it shall be made of material that allows no **measurable movement of water or aqueous solutions through the material** during use.

(3) When a “chemical-resistant suit” is specified by the product labeling, it shall be a **loose-fitting, one- or two-piece chemical-resistant garment that covers, at a minimum, the entire body** except head, hands, and feet.

(4) When “coveralls” are specified by the product labeling, they shall be a 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. The pesticide product labeling may specify that the coveralls be worn over another layer of clothing.

Note: Boldface type added by authors.

Work Clothing Versus PPE

According to the definitions given above, shirts and pants are considered work clothing, whereas coveralls made of the same material are considered PPE. Therefore, garment type, not performance of the material used for the garment, dictates protection level. The fabric used for a cotton shirt and pants, considered regular work clothing, could be exactly the same as that for a coverall, considered PPE. This differentiation has two major implications:

1. No performance data are required for coveralls, an item commonly required for PPE. This means even coveralls made with very thin, spunbond, nonwoven fabric, such as those seen in Figure 1, would meet the legal requirements for coveralls. Moreover, subtle differences (and in some cases, no differences) in the design of a long-sleeved shirt and long pants could allow the combination to be acceptable as a two-piece coverall when worn over a thin t-shirt and shorts, such as boxer shorts. The real question is, “Does the thin, nonwoven coverall or the pants and shirt described above provide the necessary protection when a coverall is required for risk mitigation?”

Figure 1. A coverall made with thin, spunbond, nonwoven fabric that meets WPS requirements.



Blue shorts seen through the “protective” coverall.

2. The handler is responsible for obtaining, laundering, and caring for work clothing, whereas the employer is responsible for furnishing and maintaining PPE. Therefore, the employer must supply a coverall and ensure that the garment is washed each

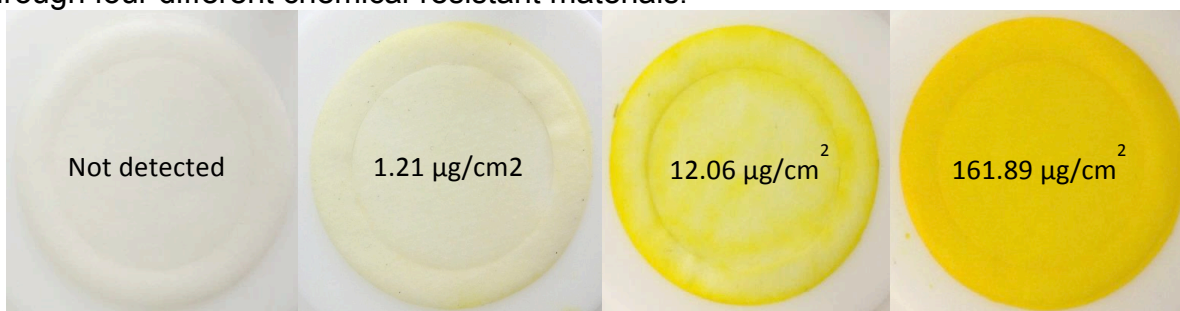
day it is worn, checked for tears, and is generally safe to use. However, workwear pants and shirt, made of the same material, would be purchased by the user and taken home for laundering. Since more than 80% of available pesticide products require only pants and shirt (Shaw and Harned, 2013), presumably many garments are being taken home for laundering. Thus, take-home contamination becomes a concern. The sheer volume of work clothing that handlers must care for poses a greater concern than those garments that must be cleaned in the workplace. The possibility of handlers using public, self-service laundries increases the chances that the necessary precautions to reduce contamination may not be taken.

Chemical-Resistant Materials

The definition of chemical-resistant in EPA's Worker Protection Standard (WPS; 40 CFR 170) requires clarity. *Chemical-resistant*, in very general terms, means that a textile or glove material will resist penetration and/or permeation of chemicals. Laboratory tests are required to determine the performance of a material against a challenge chemical; results vary considerably for different chemical-resistant materials. Chemical-resistant PPE is defined as "made of material that allows no measurable movement of the pesticide being used through the material during use" (40 CFR 170.207; EPA, 1992).

Figure 2 shows pendimethalin that has permeated through chemical-resistant materials onto collection discs. The tests were conducted for 1 hour using Prowl 3.3 EC diluted in distilled water to 5% pendimethalin. The question is, "Which of these chemical-resistant materials provides no measurable movement of the pesticide through the material during use?" The level of chemical protection provided by chemical-resistant materials depends on factors such as the challenge chemical (for example, pesticide concentrate or diluted spray solution) and duration of exposure. This level can be determined only by testing the performance of the material.

Figure 2. Collection discs from laboratory tests showing pendimethalin permeation through four different chemical-resistant materials.



Because EPA's requirement is for no measurable amount of the formulation to pass through the material, the material would have to be tested with each formulation to determine its performance. Since it is not practical to test each material and chemical/spray dilution combination, performance standards based on laboratory tests are critical for evaluation.

EPA's proposed revised definition for chemical-resistant personal protective equipment states "it must be made of material that the manufacturer has declared, in writing, to be chemical-resistant" (EPA, 2014a). It is unrealistic to expect the PPE manufacturer to declare that its items are chemical-resistant for each pesticide product that requires chemical-resistant PPE. The following is an example of a recommendation posted on a distributor's website that highlights the problem with using a term that cannot be quantified without testing requirements: "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."

The burden of responsibility has been shifted to the purchaser or user, who is expected to test the clothing against the chemical before using. Thus, either recognized performance standards need to be implemented so that manufacturers can test their garments, or a testing protocol must be developed for applicators.

Waterproof Materials

By EPA's definition, *waterproof* means a "material that allows no measurable amount of water or aqueous solutions through the material during use" (EPA, 1992). The term *aqueous solution* is left to the interpretation of the reader. The definition does not state what might be in an aqueous solution. It could include water-soluble chemicals, other chemicals, or water-based spray solutions. According to the LRM (Chapter 10), "Products in solvent category A (i.e., those with dry or water-based formulations) DO NOT require chemical-resistant gloves. Waterproof gloves provide the necessary handler protection" (EPA, 2013). If waterproof gloves are acceptable for category A, then why are waterproof headgear, apron, and boots not acceptable when applying a formulation that allows the use of waterproof gloves for application as well as mixing and loading? Have tests been conducted or are field data available to verify the use of waterproof versus chemical-resistant items? Note that headgear is used only during application (mostly with diluted spray mixes) and not during mixing and loading (concentrated product).

Examples of Pesticide Product Labels

Below are four examples of approved pesticide labels that demonstrate how unclear label language and variability in dermal protection requirements can be confusing for readers. Clarity of language is a problem with the use of the terms *some materials* and *such as*. These terms are sometimes used loosely and at other times are meant to be prescriptive. Table 2 illustrates the variability of PPE requirements for four products ranging from low to high toxicity and lower to higher levels of PPE. Color-coding is used to highlight the differences. Categories G and H require one of two glove types. EPA updated the LRM glove selection chart in September 2013 to clear up some of the confusion related to gloves and chemical resistance. However, it will take years to update all product labels through reevaluation. Registrants need to address this issue as they revise labels.

Table 2. Comparison of signal words and PPE requirements for four example pesticide labels.

Product Example	Signal Word on Label	Garment Requirement	Glove Solvent Category	Footwear Requirement	Additional PPE for Warning and Danger	
					Chemical-Resistant Headgear	Chemical-Resistant Apron
#1	Caution	Long-sleeved shirt and long pants	Category G	Shoes plus socks	No	No
#2	Caution	Coveralls over long-sleeved shirt and long pants	Category A	Chemical-resistant footwear plus socks	Yes	Yes
#3	Caution	Coveralls over long-sleeved shirt and long pants	Category H	Chemical-resistant footwear plus socks	No	No
#4	Danger	Long-sleeved shirt and long pants	Category A	Shoes and socks	No	Yes

For each example below, the text in the shaded box is verbatim from the product label.

Example 1: Text for label with signal word CAUTION.

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

Note: Some boldface type added by authors.

Example 1 is a Caution-labeled product that requires the lowest level for garment and footwear protection and a highly restrictive glove requirement of either barrier laminate or Viton®. Note the incongruity of a product that has low dermal toxicity but requires gloves that are Viton® (which are extremely expensive) or barrier laminate (which may result in fit and dexterity issues). Having the most stringent requirement for hands and the least stringent for other parts of the body is perplexing and raises questions for applicators. This example makes clear that the solvent – not the end-use product toxicity – was used to determine the glove requirement. The result is a perceived incongruity for dermal requirements.

Example 2: Text for label with signal word CAUTION.

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.

Note: Some boldface type added by authors.

Example 2, on the other hand, requires category A chemical-resistant gloves (the lowest level for hands) and higher levels of protection for the other parts of the body.

Furthermore, the label specifically mentions polyethylene and polyvinylchloride and suggests following the instructions for category A for more options. A registrant is free to select the examples if several glove types meet the requirement. However, some handlers reading this might assume that these gloves are better suited than the gloves they may already be using. Others might infer that the label discourages the use of commonly worn nitrile gloves.

Example 3: Text for label with signal word CAUTION (granular formulation).

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

Note: Some boldface type added by authors.

Example 3 is a granular product with the signal word Caution that requires use of category H gloves, either barrier laminate or Viton®. Generally, granular formulations require category A gloves, which include any glove type on the chart. This product also requires chemical-resistant footwear. EPA allows the manufacturer to propose use of PPE that exceeds the minimum level and that, if approved, may result in requirement(s) that are higher than the WPS default values. In this example, the manufacturer may have chosen gloves with a higher level of protection. In the absence of an explanation for why the usual standard of any waterproof gloves for a granular (dry) formulation was not followed, a requirement of barrier laminate or Viton® glove may be questioned. This is especially true given the impracticality of fit and dexterity or cost, respectively.

Example 4: Text for label with signal word DANGER-PELIGRO.

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.

Follow manufacturer's instruction for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

Note: Some boldface type added by authors.

Example 4 is an herbicide with the signal word Danger. In this example, the requirement for the whole-body garment has been lowered because the signal word Danger is due to primary eye irritation. Goggles or a face shield is required to protect the eyes. A long-sleeved shirt and long pants suggest that the dermal and skin irritation toxicity is relatively low. From the label, it is not clear if the chemical-resistant apron is required for any application or for handling of concentrates only. Also note that although gloves that protect against category A products are required, barrier laminate, nitrile rubber, neoprene rubber, and Viton® are listed on the label. This is possibly another example of the manufacturer opting to recommend a glove that provides higher protection.

Informational Materials Developed by Stakeholders

In addition to the issues with PPE label statements, a good deal of misinformation and outdated PPE information are available on various Internet sources. Since PPE terms lack detailed explanations and a wide variety of water- or chemical-resistant garments and accessories are referenced, stakeholders such as educators, manufacturers, distributors, and regulators sometimes attempt to supplement PPE information and requirements. Many regulators and educators do not understand how PPE is assigned for dermal protection. Some misinterpret how the precautionary statements and signal word relate to the selection of PPE. The reality is that a number of websites, including some frequently visited by individuals in the agricultural industry, recommend the use of signal words as the basis for PPE selection. Given below are two examples of text or tables from various sites that recommend or imply use of the signal word on the label as the basis for selecting coveralls. The third example cites inaccurate information regarding glove selection.

(Website sources have not been named as the goal of this paper is to examine the issues regarding PPE selection, not to identify organizations or companies with faulty information. Contact the authors with questions regarding sources.)

Recommendation to Use Signal Word for Coverall Selection

The following example from an online catalog recommends the use of signal words for coverall selection:

When choosing a protective coverall for pesticide use, review your label. There should be a signal word (such as Danger, Warning or Caution) located on your pesticide label. These words relate to the toxicity of the chemical. A toxicity class is

associated with each signal word, ranging from I to IV, with I (Danger) being the most toxic and IV (Caution) being the least.

Another example is a table from an online brochure that has incorrect information. A footnote at the bottom of the table states that the signal word (highlighted in red in the table) on the pesticide label was used to determine both the particulate protection and the splash protection classes.

Table 3. An informational table with incorrect or outdated information.

Characteristics of some commonly used pesticide coveralls (Consult manufacturers for more information)						
Material	Particulate Protection Class*	Splash Protection Class*	Liquid Proof?	Liquid chemical protection?	Breathable?	Relative Cost
Tempo®	IV	(none)	NO	NO	YES	LOW
ProShield2®	I	III	NO	YES	YES	LOW
Tyvek®	I	III	NO	NO	YES	LOW
Tyvek® QC/ sewn seams	I	II	NO	YES	NO	LOW
Tyvek® QC / sealed seams	I	II	YES	YES	NO	Moderate
Kleenguard® LP	I	III	NO	NO	YES	LOW
Tychem® SL / surged seams	I	I	NO	YES	NO	Moderate
Tychem® SL / sealed seams	I	I	YES	YES	NO	HIGH
PVC coverall	I	I	YES	YES	NO	HIGH
PVC suit	I	I	YES	YES	NO	Moderate
*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)						

Text with Inaccurate Glove Selection Information

The following text regarding glove selection was posted on an informational website. The source of the glove information included in an educational presentation posted on the website is not known. The text does not agree with the requirements in the EPA Chemical Resistance Category Selection Chart for Gloves (EPA, 2013), which are based on the solvents in the concentrated product. For example, the information for nitrile and neoprene does not match that provided in the chart.

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

Closing Comments

The information presented in this paper highlights problems with the criteria for assigning PPE and in communicating this information to pesticide handlers and their employers. Millions of dollars are spent on exposure studies. Moreover, registrants and EPA spend considerable time and effort trying to minimize risk for pesticide handlers. Safety measures are also covered in training and certification programs. Confusing, inaccurate, and/or general PPE statements on labels and/or outreach materials negate the time, effort, and resources expended in conducting exposure studies, risk assessment, risk mitigation, and training. Language on labels and in training materials needs to be specific and accurate.

EPA's *Pesticides: Health and Safety* (Protecting Workers) website states, "The registration review program challenges EPA to continuously improve its processes, science, and information management while maintaining a collaborative and open process for decision-making" (EPA, 2014c). Several minor changes, such as revising glove terminology, have been made in recent years. However, these modifications and the proposed Worker Protection Standard changes do not address the underlying factors that serve as the foundation for assigning PPE. As mentioned earlier, the PPE guidance manual states that "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" (EPA, 1993). Assigning level of protection, in accordance with performance standards, is essential and provides consistent, defensible PPE requirements.

International standards specifically designed to assess performance of PPE for pesticide operators have been developed in the last two decades. Research conducted in the United States has played an important role in the development of these standards. The authors recommend that EPA, the chemical industry, state pesticide regulatory agencies, pesticide safety educators, and experts involved in PPE research and standards development work jointly to address the issues raised in this paper. International performance standards may be an effective basis for revising definitions and the process for assigning PPE required for risk mitigation. The standards could help:

- Develop consistent levels of protection for garments and gloves based on performance. This would address inconsistencies in requirements to protect different parts of the body (e.g., pants and shirt and Viton® gloves; chemical-resistant headgear and polyethylene gloves).
- Clarify the quantification of terms such as *chemical-resistant* and *waterproof*. Descriptions will no longer be necessary since 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.
- Clearly communicate instructions for cleaning. Instructions for use are mandated for PPE that is in compliance with the performance standard. These instructions include information and warning statements related to selection, use, and care. Therefore, it would be simpler for users to determine proper cleaning procedure as material often determines the cleaning required for the item.

A dialogue among risk assessors, federal and state policymakers, members of the crop protection industry, PPE industry representatives, members of standards development organizations, researchers, pesticide handlers, and trainers is needed to address the current issues leading to unclear and inconsistent PPE requirements and pesticide labeling statements.

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