Maisons-Alfort, 22 October 2014

The Director General

OPINION
of the French Agency for Food, Environmental and Occupational Health & Safety

on the effectiveness of protective clothing worn by applicators of plant protection products

ANSES undertakes independent and pluralistic scientific expert assessments.
ANSES primarily ensures environmental, occupational and food safety as well as assessing the potential health risks they may entail.
It also contributes to the protection of the health and welfare of animals, the protection of plant health and the evaluation of the nutritional characteristics of food.

It provides the competent authorities with all necessary information concerning these risks as well as the requisite expertise and scientific and technical support for drafting legislative and statutory provisions and implementing risk management strategies (Article L.1313-1 of the French Public Health Code).

Its opinions are made public.
This opinion is a translation of the original French version. In the event of any discrepancy or ambiguity the French language text dated 22 October 2014 shall prevail.

On 8 August 2011, ANSES issued an internal request on the question of the effectiveness of protective clothing worn by applicators of plant protection products[1].

I. BACKGROUND AND PURPOSE OF THE REQUEST

When examining marketing authorisation (MA) applications for plant protection products, in accordance with Regulation (EC) No 1107/2009[2], ANSES systematically assesses the risk associated with the use of these products for the applicator/operator. Exposure is estimated initially using models developed from experimental data from representative "field" studies, taking into account the conditions of application (type of equipment, crop, concentration of active substance, dilution, etc.). The models currently recognised in Europe and most widely used (BBA, POEM, EUROPOEM and the forthcoming EFSA model) enable operator[3] exposure to be estimated, with or without work clothing and/or personal protective equipment (PPE).

[1] This internal request also incorporates the response to the formal request made to ANSES by the National Agri-food and Forestry Federation branch of the French General Labour Confederation, which was received on 19 September 2011 (2011-SA-0249).

[2] Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC.

[3] For the purposes of Regulation (EC) No 1107/2009, the following definitions apply:

- operators are people who are involved in activities relating to the application of a plant protection product, such as mixing, loading, application, or relating to cleaning and maintenance of equipment containing a plant protection product; operators may be professionals or amateurs;

- workers are people who, as part of their employment, enter an area that has previously been treated with a plant protection product or handle a crop that has been treated with a plant protection product.

In some cases, the risk to the operator is only acceptable under Council Regulation (EC) No 1107/2009 if they are wearing work clothing and/or PPE. However, the information available on the clothing and PPE available on the market is not always sufficient to ascertain whether they provide the level of protection required in each situation.
Moreover, in its 2010 report, AFSSET had demonstrated differences between the performances offered by certain PPE (Category III Type 3 and 4 coveralls) and the results from laboratory testing according to the NF EN 374-3:2004 Standard[4,5].
Under Regulation (EC) No 546/2011[6], when a product's conditions of use require work clothing and/or PPE to be worn, authorisation is only granted if this is effective, available from distributors and suited to the work situation. The Agency's internal request seeks to analyse the conditions under which these requirements are implemented and, where appropriate, to formulate recommendations that could be included in the framework of European regulations. Given the nature of the plant protection products and the operator's activities, it also seems necessary to propose a specific approach for PPE intended to provide protection from plant protection products.

This internal request mainly sought answers to the following questions:

- What work clothing and PPE are available on the market and offered to farmers, and what kind of information is provided with them?
- In practice, what work clothing and PPE do the farmers actually wear for applying plant protection products? What are their selection criteria?
- What are the performances of the work clothing and PPE that is actually worn, in terms of results of laboratory tests conducted according to the available standards, but also the results of tests conducted under real field conditions? Do these performances vary according to the products used?
- What can be inferred about:
    - the information to be sought from manufacturers of work clothing and PPE, to ensure that users are adequately informed about the performance of what they purchase?
    - the proof required from manufacturers of plant protection products, concerning the work clothing and PPE they recommend, to be made mandatory in their application for marketing authorisation for the different phases and uses of their products?
    - the studies, research and standards work to be continued or undertaken in order to improve the state of knowledge?

This internal request also falls within the framework of Action 112 of the French Ecophyto plan on prevention of occupational risks when using plant protection products, whose aim is to develop personal protective equipment adapted to user needs.

Finally, it should be noted that in parallel to this internal request, the Agency has taken other initiatives towards better documenting of occupational exposure to plant protection products and specifying the characteristics of work clothing and/or PPE that would enable the required level of protection to be reached:

- Firstly, following an Opinion of the Agency published in October 2012, ANSES now systematically asks manufacturers, in their applications for marketing authorisation of a plant protection product, to provide precise information on the types of PPE and/or work

[4] NF EN 374-3 April 2004. Protective gloves against chemicals and micro-organisms - Part 3: determination of resistance to permeation by chemicals. The methodology is comparable to that of the NF EN ISO 6529:2001 Standard.

[5] In its 2010 report**,** drawing on the NF EN 374-3:2004 Standard, AFSSET demonstrated that the three Category III Type 3 coveralls tested had a breakthrough time (resistance to permeation) of more than 480 minutes for the three undiluted plant protection products used in the study. However, the Category III Type 4 coverall had a breakthrough time of more than 480 minutes for just one of the products, with the breakthrough time for the two other products being less than 30 minutes.

[6] Commission Regulation (EU) No 546/2011 of 10 June 2011 implementing Regulation (EC) No 1107/2009 of the European Parliament and of the Council as regards uniform principles for evaluation and authorisation of plant protection products.

clothing they consider appropriate for the protection of workers and operators. On this basis, ANSES examines the applications and specifies in its opinions the PPE and/or protective clothing required.

- Secondly, the Agency has set up an expert group devoted to the study of exposure of agricultural workers to pesticides. It aims to establish an inventory of the scientific data available on certain specific exposure situations, primarily to identify potential study and research needs. It should be issuing its conclusions in early 2015.

II. ORGANISATION OF THE EXPERT APPRAISAL

The expert appraisal was carried out in accordance with French Standard NF X 50-110 “Quality in Expert Appraisals – General requirements of Competence for Expert Appraisals (May 2003)”. The study can be considered original in that the Agency sought to acquire new data (studies entrusted to external organisations in 2012 and 2013) prior to conducting its expert appraisal, which was carried out by the Regulated Products Department with the support of the Expert Committee on Plant protection products: chemical substances and preparations, which debated the subject at its meeting of 9 July 2014.

III. INFORMATION ON VOCABULARY

To facilitate reading of the summary of the analysis work presented below, the meaning of some of the terms used needs to be clarified:

Personal protective equipment (PPE): for the purposes of Directive 89/686/EEC, PPE is defined as "any device or appliance designed to be worn or held by an individual for protection against one or more health and safety hazards". This Directive has been transposed into the French Labour Code[7]. This equipment varies greatly, both in terms of the risks it protects against and its degree of complexity. Examples include protective clothing (body protection), glasses (eye protection), gloves (hand protection) and masks (face protection).
Directive 89/686/EEC is based on the following principles:

- Manufacturers must guarantee that their product complies with the essential health and safety requirements stipulated in the Directive.
- These essential requirements (design principles, safety of PPE, comfort and effectiveness factors, etc.) establish objectives to be achieved but do not impose specific technical solutions or defined specifications.
- The Directive refers to harmonised and sector-specific standards that contain the technical specifications for designing and manufacturing PPE that meet the essential requirements and provide protection from one or more risks identified by the manufacturer.
- These harmonised standards make it easier to justify compliance with the essential requirements.
- Bodies notified by the Member States are responsible for assessing the compliance of PPE presented by the manufacturer, using the harmonised standards.
- In the absence of harmonised standards, these "notified bodies" can assess the compliance of these typical examples of equipment by conducting an expert assessment.
- When the compliance assessment process is complete, if the PPE obtains an CE-type approval certificate from the notified body, the manufacturer can issue a declaration of conformity and the PPE may be placed on the market.
- PPE providing protection from chemical stresses also undergoes one of the two procedures mentioned in Article 11 of Directive 89/686/EEC, namely the 'EC' quality control system for

[7] French Labour Code - Part Four: Health and safety at work - Book III: Work equipment and means of protection - Title 1: Design and marketing of work equipment and means of protection.

the final product, or the system for ensuring 'EC' quality of production by means of monitoring.

PPE is classified into three categories under Directive 89/686/EEC. The third category refers to PPE of complex design intended to protect against mortal danger or hazards that can seriously and irreversibly damage health, and for which the designer assumes the user is unable to detect the immediate effects in time.
This category contains PPE that can only offer limited protection over time against chemical stresses.

The Directive refers to harmonised standards for classifying the various types of personal protective clothing that protect against chemical risk. Thus, four types relate to liquid and solid products (see also Annex 1):
Type 3, for clothing impermeable to liquids in a continuous jet;
Type 4, for clothing impermeable to mists, i.e. resistant to penetration of sprayed liquids;
Type 5, for clothing impermeable to chemicals in the form of solid particles;
Type 6, for clothing intended for risks associated with accidental exposure to sprays or splashes.

Work clothing: basically cotton or cotton/polyester coveralls, commonly worn by farmers and which have high mechanical resistance, but which cannot be regarded as Category III PPE within the meaning of the Directive. They should not be confused with protective clothing, which is one type of PPE.

Harmonised standards applicable to the certification of PPE: there are harmonised European standards related to the European PPE Directive (equivalent to the French NF EN standards), which cover different categories of PPE (gloves, glasses, protective clothing for use with liquid chemicals, gases, etc.). For protection against chemical risks, the standards mainly specify how to conduct penetration and permeation tests, two key types of test for assessing the level of performance provided by a material and/or the seams with regard to resistance to chemical penetration and/or permeation.

The harmonised European standards currently available for chemical protective clothing are mainly for industrial uses, and are not fully adapted to agricultural uses. For this reason, standardisation work was recently reactivated, on France's initiative, to establish harmonised European standards covering all PPE for agricultural use. This work draws on an international standard requiring revision and supplementation, the ISO 27065 Standard published in 2011, entitled "Protective clothing - Performance requirements for protective clothing worn by operators applying liquid pesticides". This standard itself refers to two other standards for penetration and permeation tests.

IV. SUMMARY OF ANALYTICAL WORK

The work was organised into two stages, the first involved carrying out studies while the second concerned the expert appraisal work. As part of the first stage, the Agency identified three studies that were entrusted to three specialist organisations, to be conducted in two phases:

The first phase of studies concerned a survey conducted by IRSTEA[8], on the inventory of PPE[9] and work clothing available on the French market (survey of distributors) and representative of farming practices (survey of farmers). Part 1 below summarises the results of this study.

The second phase of studies involved selecting a panel of PPE and work clothing representative of French practices (based on the first study phase), and testing them in the laboratory, conducted by the IFTH[10] (the notified body under the PPE Directive), in order to verify their compliance with the

[8] IRSTEA = National Research Institute of Science and Technology for Environment and Agriculture
[9] See Annex 1
[10] IFTH = French Textile-Apparel Institute

harmonised standards by exposing them to different plant protection products (diluted and undiluted). Part 2 below summarises the results of this study.

At the same time, a study of exposure of operators wearing PPE was conducted in a vineyard under real conditions, according to the guidance document of the OECD[11], in order to estimate experimentally the level of protection offered by these PPE. Part 3 below summarises the results of this study.

Following this phase of studies, analytical work was conducted by ANSES's Regulated Products Department, with the support of the Expert Committee on Plant protection products: chemical substances and preparations. Part 4 below summarises the results of the studies conducted, and provides a basis for the conclusions and recommendations of this Opinion.

The study reports provided by the three external organisations are being published on the Agency's website at the same time as this Opinion.

1. Inventory of PPE and work clothing available on the market and representative of farming practices

The IRSTEA survey was conducted among distributors and farmers.

1.1. Survey of distributors

The equipment on the market was characterised with the help of a survey of equipment distributors and specialised websites.

Mail order via the Internet is still very limited among farmers, since only 6% of farmers questioned reported having used it (FNSEA survey, 2010). However, the products available are generally no different to those from the distributors described below in the telephone survey.

1.1.1. Materials and Methods

The industry sectors explored were cereals, market gardening (including greenhouse crops), wine growing and arboriculture.
A telephone survey was conducted among distributors of personal protective equipment and work equipment. The sampling frame was established from a list extracted from the France Télécom telephone directory. Each distributor is clearly identified (name, address and telephone number).
The survey, conducted among 67 distributors using a questionnaire, focused on three areas:

- Establishment of a data sheet for each distributor (address, type of crop, how they sell and/or provide advice),
- A description of the personal protective equipment (dermal, respiratory, hearing, etc.) and work equipment available from the distributor,
- Advice given by distributors on the equipment.

The survey also included an interview on the breakdown of sales of different types of protective equipment: single-use coverall vs reusable coverall.

1.1.2. Results

The questionnaire was validated by:

- A phase to test the survey on ten farmers. This served to validate the terms used in the questionnaire and the logical sequence of the questions.
- Visits to a dozen distributors to verify the range of equipment they actually offer.

[11] Series on Testing and Assessment No. 9. Guidance Document for the Conduct of Studies of Occupational Exposure to Pesticides During Agricultural Application.

The survey was conducted from mid-January to late March 2012. Sixty-seven distributors agreed to take part in the survey, 31 refused.
The response rate in mainland France breaks down as follows:

- South west: 28 responses
- South east: 9 responses
- North west: 19 responses
- North east: 11 responses

These distributors of personal protective equipment and work equipment have a diverse clientele: 94% of distributors sell to cereal-polyculture-livestock farmers, 45% to wine growers, 35% to arboriculturists and 15% to market gardeners. None of the distributors sell exclusively to a single sector.

In the description of the PPE and work clothing provided to French farmers, more details were available for equipment intended for protecting the body than for the others, and these results helped select the equipment that was tested (permeation and penetration testing) by the IFTH in the second work phase.

Similar surveys on dermal protection of hands and respiratory protection are available in IRSTEA's report entitled *"Pratiques et utilisation des équipements de protection individuelle et de travail par les agriculteurs lors de la manipulation aux produits phytopharmaceutiques" ["Practices and use of personal protective equipment and work equipment by farmers when handling plant protection products"]*, made available on the Agency's website.

The results are shown in Table 1. They indicate, for each type of equipment, the percentage of distributors stocking the equipment, as well as whether or not it is used (according to the distributors' knowledge) for each application phase (preparation of the solution, treatment, cleaning) and its level of comfort, according to the information available from the distributors.

Table 1: Result of the survey of distributors concerning body protection
Source: "Pratiques et utilisation des équipements de protection individuelle et de travail par les agriculteurs lors de la manipulation aux produits phytopharmaceutiques" ["Practices and use of personal protective equipment and work equipment by farmers when handling plant protection products"] IRSTEA

Trade name of coverall or clothing	PPE: Category III and Type	Presence*	Solution preparation*	Treatment*	Cleaning*	Comfort (very poor to very good)$
Tyvek Classic coverall E	Type 5/6	91%	70%	43%	14%	Moderate
Protect Pro coverall E	Type 5/6	25%	17%	9%	4%	Satisfactory
Microgard 2000 coverall E	Type 5/6	25%	22%	9%	16%	Moderate
Tyvek Classic Plus coverall E	Type 4/5/6	34%	24%	13%	17%	Poor/moderate
Proshield coverall E	Type 4/5/6	24%	24%	15%	7%	Poor
3M coverall E	Type 4/5/6	15%	15%	11%	6%	Poor
Microporous coverall E	Type 4/5/6	9%	9%	4%	7%	Poor
Tychem C coverall E	Type 3/4/5/6	49%	46%	35%	27%	Very poor
Tychem F coverall E	Type 3/4/5/6	9%	9%	3%	9%	Very poor
Microchem 3000	Type	7%	7%			Very poor

Trade name of coverall or clothing	PPE: Category III and Type	Presence*	Solution preparation*	Treatment*	Cleaning*	Comfort (very poor to very good)$
coverall [E]	3/4/5					
Tychem F apron [E]	Type 3/4/5/6	60%	54%	-	7%	Satisfactory
S-Protech apron [E]	Type 3/4/5/6	27%	27%	-	22%	Satisfactory
Work clothing	-	97%				
Molinel coverall (60% cotton, 40% polyester); 310 g/m^2	-	49%	31%	27%	13%	Satisfactory
Factory coverall (65% polyester, 35% cotton); 245 g/m^2	-	43%	38%	16%	24%	Satisfactory
Oilskin	-	71%	12%	22%	48%	Satisfactory

* Explanations for the data shown in the table. Example from the first line: the Tyvek Classic Category III Type 5/6 coverall is stocked by 91% of distributors and, according to the distributors, is used for solution preparation in 70% of cases, for treatment in 43% of cases and for cleaning in 14% of cases.
[E] PPE within the meaning of the PPE Directive
$ Note: comfort is rated from 1 to 5:
1. Very poor comfort - 2. Poor comfort - 3. Moderate comfort - 4. Satisfactory comfort - 5. Very comfortable

According to the distributors, not all farmers wear PPE or work clothing for phases in which they are in contact with plant protection products. Comfort and price are the main criteria taken into account by farmers when choosing work clothing, protective clothing and PPE. The distributors mentioned a change in practices relating to the purchase of protective and work equipment since the introduction of the French individual Certiphyto certificate. Distributors are identified as a means of relaying messages on prevention, regulations and recommendations on work clothing, protective clothing and PPE for farmers. The farmers seek advice on use, equipment care and hygiene. The distributors themselves seek support for messages on prevention.

1.2. Survey of farmers

This part of the project aimed to identify the protective and work equipment used by and acceptable to farmers, and to characterise farming practices.
This second stage was based on two actions:

- A telephone survey of a representative sample of the French agricultural population, 1356 farmers, with the sample being selected based on data from Agreste[12].
- A field survey of 100 farmers, in order to identify the differences between the information declared by telephone and the reality.

1.2.1. Materials and Methods

The population targeted by this study was farmers using plant protection products and based in mainland France, working on holdings in one of the following four areas: field crops, wine growing, arboriculture and market gardening.
The sample of farmers was selected based on the 2010 agricultural census, in order to define the number of farmers to question according to region and type of holding. The sampling frame was

[12] http://agreste.agriculture.gouv.fr/page-d-accueil/article/donnees-en-ligne

defined from a list extracted from the France Télécom telephone directory: this clearly identifies each farmer (name, address and telephone number).
Using a questionnaire, conducted among 1356 farmers selected at random and spread across France's farming regions, the survey focused on three areas:

- Establishment of a data sheet for each farmer (address, type of crop, how they buy and/or obtain advice);
- A description of the personal protective equipment (dermal, respiratory, hearing, etc.) and the work equipment;
- Advice received from distributors on the equipment.

Following the telephone survey, another sample of farmers was selected from the initial sample, who agreed to continue the study.

A field survey was then conducted through interviews with 100 farmers who reported wearing personal protective equipment or work clothing when handling plant protection products. These 100 farmers were selected at random taking each one's availability into account, from throughout mainland France.
These interviews were conducted on the farms, in order to observe the farmers' actual practices when they used the treatments.

The field observations were used to make an inventory of the clothing actually worn, the selection criteria, the place of purchase and any possible prescribers. Where appropriate, they took into account regional differences according to the local availability of PPE, or differences according to the farmer's type of activity, status (farm operator, farm worker), and according to the size of the holding. The criteria for selecting and accepting to wear the PPE were identified in the survey: availability, type, comfort, price, effectiveness as assessed by the farmer, advice or prescription. This work helped to determine the current level of satisfaction and areas for improvement according to the farmer.

The various phases of handling plant protection products were taken into account in the survey in order to identify the steps in which the operator wore/did not wear the protection. The "protection life cycle" within the farm was monitored: from the choice and purchase of the PPE or work clothing, through to its management (care, storage, cleaning, renewal).

1.2.2.Results

The 1356 farmers who accepted to take part in the telephone survey can be broken down as follows: 474 cereal farmers, 371 wine growers, 452 arboriculturists and 59 market gardeners.
The sample of 100 farmers selected for the field survey was made up of 33 cereal farmers, 29 arboriculturists, 28 wine growers and 10 market gardeners.
In the description of the protective and work equipment actually worn by French farmers, more details were available for equipment intended for protecting the body than for the others, and these results helped select the equipment that was tested (permeation and penetration testing) by the IFTH in the second study phase.
Similar surveys on dermal protection of hands and respiratory protection are available in IRSTEA's report entitled *"Pratiques et utilisation des équipements de protection individuelle et de travail par les agriculteurs lors de la manipulation aux produits phytopharmaceutiques" ["Practices and use of personal protective equipment and work equipment by farmers when handling plant protection products"]*.

The results are shown in Table 2. They show, for each type of equipment, the percentage of farmers reporting that they own it, as well as the application phases (preparation of the solution, treatment, cleaning) in which they use it, and its associated level of comfort.

Table 2: Result of the telephone survey of farmers concerning body protection. *Source: "Pratiques et utilisation des équipements de protection individuelle et de travail par les agriculteurs lors de la manipulation*

aux produits phytopharmaceutiques" ["Practices and use of personal protective equipment and work equipment by farmers when handling plant protection products"] IRSTEA

PPE or protective clothing	Presence	Solution preparation*	Treatment with cabin*	Treatment without cabin*	Cleaning*	Comfort (very uncomfortable to very comfortable)$
Coverall Cat. III, Type 5/6	56%	52%	24%	32%	28%	Moderate comfort
Coverall Cat. III, Type 4/5/6	36%	26%	12%	24%	9%	Uncomfortable
Coverall Cat. III, Type 3/4/5/6	25%	8%	2%	6%	6%	Very uncomfortable
Apron Cat. III, Type 3/4/5/6	14%	14%	-	-	3%	Satisfactory comfort
Work clothing	88%	64%	76%	12%	58%	Satisfactory comfort
Oilskin	36%	22%	-	36%	28%	Satisfactory comfort

* Explanations for the data shown in the table. Example from the first line: the Tyvek Classic Category III Type 5/6 coverall is owned by 56% of farmers and, according to the farmers, is used for solution preparation in 52% of cases, for treatment in a cabin in 24% of cases, for treatment without a cabin in 32% of cases and for cleaning in 28% of cases.
$ Note: comfort is rated from 1 to 5 1.Very uncomfortable 2.Uncomfortable 3.Moderate comfort 4.Satisfactory comfort 5.Very comfortable

The farmers reported that the main criteria for selecting protective equipment are:

- 47%, the need to protect themselves;
- 38%, the availability from the distributor;
- 28%, the price of the equipment;
- 17%, the presence of employees;
- 11%, whether the equipment is reusable or for single use.

48% of farmers reported spontaneously that they were aware of being mainly exposed via the skin, which led them to wear protective equipment in the different product handling phases. Work clothing was the main body protection equipment worn by farmers when using plant protection products. Eighty-eight per cent of the sample reported that they wore it because of its comfort compared to standardised skin protection equipment. This statement is confirmed by the observation: 43% of farmers wear work or protective equipment; this mainly relates to farmers keeping their equipment on throughout the different product handling phases.
The skin protection equipment most often worn by the farmers in the sample is Category III Type 5/6 coveralls (56%). The higher the level of protection against chemical risk, the more the coverall is water- and air-tight, and the less frequently the farmers wear this type of equipment due to thermal discomfort. This statement is confirmed by the observation: 52% of farmers observed mainly wear this type of protection.

Mixing-loading phase:
The main phase during which the farmer wears personal protective equipment is during preparation of the solution, due to the use of concentrated products. This statement is confirmed by the observation: 52% of farmers observed wear protection or work clothing, with no difference being observed between different crops. For the other phases, the wearing of dermal protection decreases. Wearing of protective aprons (PPE) is increasing because they are regarded as more practical and easier to remove than coveralls before getting in a tractor. This statement should be compared with the observation: 14% of farmers observed wear this equipment.

Application phase:

If farmers treat their crops with a sprayer towed by a tractor or self-propelled vehicle with a cabin, wearing of protection decreases, except for the work clothing which is worn by 76% of farmers. This statement is confirmed by the observation: 72% of farmers observed wear this type of clothing, like a "second skin", but report that they take it off in hot weather.

Cleaning phase:
During cleaning, an oilskin over the work clothing or a protective coverall is the preferred clothing "to avoid getting wet". Type 5/6 or 4/5/6 PPE is not appropriate, the dampness is felt when the equipment is cleaned with large quantities of water and the cleaning takes more than 10 minutes. Aprons are only worn by farmers in 3% of cases, the same people who also wear them for preparing the solution.
This statement is confirmed by the observation: 33% of farmers wear a Type 5/6 or 4/5/6 coverall.

Storage of protective equipment:
Fifty-eight per cent of farmers reported that they store their protective equipment in a clean place, separate from used equipment. Only 28% of farmers observed stored their PPE in suitable conditions.

Cleaning of protective equipment:
Of the 57% of farmers who use single-use coveralls, very few dispose of them at the end of the day. Work clothing is cleaned at least once a week and Type 3/4/5/6 coveralls are cleaned when treatment is complete or at the end of the week. The statements are confirmed by the observation: 48% of farmers interviewed in the field report that they regularly clean their protective equipment.

The observations provided the following additional information. Wearing of protection and compliance with the recommended conditions for use decline throughout the working day: the required PPE is worn for the first mixing and loading operation, but this vigilance decreases for subsequent operations (for example, coveralls open to the torso, no gloves worn). Thus, only 18% of farmers observed wear suitable protection continuously throughout the working day, i.e. during the different product handling phases, from preparation of the solution through to cleaning of the equipment.

1.3 Conclusion

Farmers generally but not systematically wear PPE or work clothing during the different product handling phases. The wearing of this PPE or work clothing changes according to the recommendations.
The farmers reported that the main criteria for selecting protective equipment are, in decreasing order of importance: the need to protect themselves, the availability from the distributor, the comfort of the equipment, the price of the equipment. They also stated that they were aware that they had to protect themselves. This awareness increases following participation in Certiphyto training. The main phase during which the farmer wears personal protective equipment is during preparation of the solution, although the wearing of protection decreases over the course of the day during the successive phases. During the application phase a work coverall is worn in most cases, and PPE may be worn in arboriculture and wine, growing depending on the properties of the preparations. During the cleaning phase, wearing of an oilskin over work clothing is preferred. The level of comfort decreases with the level of protection offered by the PPE (Type 6 to 3), and discomfort is the main reason for wearing work clothing instead. Single-use coveralls are not systematically thrown away.

Based on the results of these surveys and field observations, laboratory tests were implemented on some of the clothing/equipment.

2. Permeation and penetration tests conducted on chemical protective clothing and work clothing worn by farmers

Based on the results of the inventory of PPE, work clothing and chemical protective clothing available on the French market and representative of farming practices, permeation and penetration tests were implemented by the French Textile-Apparel Institute (IFTH), the accredited laboratory for these tests. These tests were conducted according to the ISO 22608:2004 and EN ISO 6529:2001 Standards[13].

2.1. Materials and Methods

2.1.1. Materials

The PPE and work clothing used for the first test campaign was chosen based on the results of the survey conducted by IRSTEA of distributors of protective equipment. The equipment chosen for this first test phase was that most widely stocked by the distributors. The S Protec (Syngenta-Manulatex) and Microchem 4000 (Microgard) aprons were also added in order to compare them with the Tychem F apron (Dupont).
In addition, in a second test campaign, work coveralls treated with water-repellent coating available on the market were tested. The water-repellent treatment is a surface treatment of the fabric to reduce water penetration in the fabric. It should be noted, however, that no claim is associated with these coveralls with regard to protection against chemical risk, and that the water-repellent treatment cannot therefore be considered as solely for chemical protection, as has been reported elsewhere[14].

The characteristics of the work clothing and PPE used for the two test phases are summarised in the table below:

Work coveralls	PPE
• Molinel coverall *60% cotton / 40% polyester; 310 g/m²* • Hoste coverall *100% cotton; 350 g/m²* • Factory coverall *65% polyester / 35% cotton; 245 g/m²* • Guy Cotten coverall, 2 zip pro *65% polyester / 35% cotton; 280 g/m²*; *water-repellent treatment* • Biomodi coverall, 1 zip pro *65% polyester / 35% cotton; 300 g/m²*; *water-repellent treatment* • HEROS BLISTER coverall *65% polyester / 35% cotton; 230 g/m²*; *water-repellent treatment*	• Tyvek Classic Cat III, Type 5/6 (Dupont) • Tyvek Classic Plus Cat III, Type 4/5/6 (Dupont) • Tychem C Classic Cat III, Type 3B/4/5/6 (Dupont) • S Protec apron Cat III – Type PB (3) (Syngenta-Manulatex) • Tychem F apron-tunic Cat III – Type PB (3) (Dupont) • Microchem 4000 apron (Microgard)

[13] - International Organization for Standardization Protective clothing (ISO). Protection against liquid chemicals - Measurement of repellency, retention, and penetration of liquid pesticide formulations through protective clothing materials. (Standard No ISO 22608:2004). Geneva, Switzerland: ISO; 2004.
- NF EN ISO 6529:2001. Protection against chemicals - Determination of resistance of protective clothing materials to permeation by liquids and gases.
[14] Dermal Exposure of Pesticide Applicators as a Measure of Coverall Performance Under Field Conditions; K. MACHERA, A. TSAKIRAKIS, A. CHARISTOU, P. ANASTASIADOU and C. R. GLASS; Ann. Occup. Hyg., Vol. 53, No. 6, pp. 573–584, 2009.

The plant protection products used in these two test phases were selected according to several criteria:

- Several types of formulation represented: CS (capsule suspension), SC (suspension concentrate), WG (water-dispersible granule), SL (soluble [liquid] concentrate), EC (emulsifiable concentrate);
- Different types of biological functions represented: herbicide, fungicide, insecticide;
- Preparations marketed in France.

Preparations used in the laboratory tests.

Formulation name - Batch No	MA No	Active substance	Formulation type
Noverxone/Anti-liseron Nufarm® - 311101927	2010139	2,4-D, dimethylamine salt	Soluble concentrate
Traffic Allées® - 309011230	2020216	Isoxaben	Suspension concentrate
Rovral Aqua Flo® - 0007974747	9200262	Iprodione	Suspension concentrate
Weedazol TL® - 311091574	6000067	Aminotriazole	Soluble concentrate
Sirbel UD® - EV36001772	2010552	Iprovalicarb	Water-dispersible granules
Sekoya® - 59142	9700467	Fluazinam	Suspension concentrate
Reldan 2M® - 16753905	2120086	Chlorpyriphos-ethyl	Emulsifiable concentrate
Success 4® - P199287lbl05	2060098	Spinosad	Suspension concentrate
Opus® - 0006106503	9200020	Epoxiconazole	Suspension concentrate

2.1.2. Methods and reference frameworks

Two dilution factors were tested on most of the equipment, with the exception of the Tychem F apron that was tested with three dilutions. The tested dilutions correspond to those for the preparation as sold (i.e. undiluted), the dilution of the solution under the terms of the MA, and, for the Tychem F apron, the dilutions that may be encountered during the sprayer cleaning phase. The tests on the undiluted and diluted preparation aimed to identify the performance with regard to the preparation concentrations found during the mixing-loading and application phases.
The plant protection preparation ODENA UD (or SIRBEL UD), a water-dispersible granule, was not tested undiluted on the equipment, as the permeation and penetration tests are unsuited to solid preparations. It should be noted that exposure when handling WG preparations is low.

For the first test campaign, the penetration and permeation tests were conducted on the material and seams of the equipment. Tests on the seams are necessary for certification but they only give an indication about the equipment's manufacture and finishes, and were therefore not performed in the second test campaign.
Sampling times in the permeation tests were chosen according to the different estimated exposure times, with 8 hours corresponding to an entire working day and shorter durations simulating shorter tasks such as mixing-loading and cleaning.

In the second test campaign, the work coveralls treated with water-repellent coating were washed. Washing was carried out in accordance with the NF EN ISO 6330:2012 Standard: Domestic washing and drying procedures for textile testing. The washing/drying protocol applied to the study tests was as follows: type A1 washing machine, cycle 6M-60°C, three successive wash cycles, ECE 98 detergent, drying method C - dry flat, no ironing.

Tables 3 and 4 show the sampling plans for the protective equipment-clothing/plant protection preparations tested.

Table 3: Sampling plan for the equipment-clothing/plant protection preparations tested in the first test campaign

		Plant protection preparations tested			
		Anti-liseron/ Noverxone (SL) Batch no: 311101927 MA: 2010139	**Traffic Allées (SC)** Batch no: 309011230 MA: 2020216	**Rovral Aqua Flo (SC)** Batch no: 07974747 MA: 9200262	**Odena UD or Sirbel UD (WG)** Batch no: EV36001772 MA: 2010552
		Analysis of 2,4-D (120 g/L)	Analysis of isoxaben (55.6 g/L)	Analysis of iprodione (500 g/L)	Analysis of iprovalicarb (90 g/kg)
Work clothing/protective clothing/PPE to be tested	Molinel cotton coverall (60% cotton, 40% polyester); 310 g/m^2 ¤	Penetration d = 1 d = 1/50	Penetration d = 1 d = 1/28	Penetration d = 1 d = 1/667	Penetration d = 1/115
	Hoste cotton coverall (100% cotton); 350 g/m^2	Penetration d = 1 d = 1/50	Penetration d = 1 d = 1/28	Penetration d = 1 d = 1/667	Penetration d = 1/115
	Factory cotton coverall (65% polyester, 35% cotton); 245 g/m^2 ¤	Penetration d = 1 d = 1/50	Penetration d = 1 d = 1/28	Penetration d = 1 d = 1/667	Penetration d = 1/115
	Tyvek Classic Cat III Type 5/6 (Dupont) E,¤	Penetration d = 1 d = 1/50	Penetration d = 1 d = 1/28	Penetration d = 1 d = 1/667	Penetration d = 1/115
	Tyvek Classic Plus Cat III, Type 4/5/6 (Dupont) E,¤ ▲	Penetration d = 1 d = 1/50 Permeation d = 1 d = 1/50	Penetration d = 1 d = 1/28 Permeation d = 1 d = 1/28	Penetration d = 1 d = 1/667 Permeation d = 1 d = 1/667	Penetration d = 1/115 Penetration d = 1/115
	Tychem C Classic Cat III, Type 3B/4/5/6 (Dupont) E,¤ ▲	Penetration d = 1 d = 1/50 Permeation d = 1 d = 1/50	Penetration d = 1 d = 1/28 Permeation d = 1 d = 1/28	Penetration d = 1 d = 1/667 Permeation d = 1 d = 1/667	Penetration d = 1/115 Penetration d = 1/115
	S-Protec apron Cat III – Type PB (3) (Syngenta-Manulatex) E ▼	Permeation d = 1	Permeation d = 1	Permeation d = 1	-
	Tychem F apron-tunic Cat III – Type PB (3) (Dupont) E,¤ ▼	Permeation d = 1 d = 1/100 d = 1/1000	Permeation d = 1 d = 1/100 d = 1/1000	Permeation d = 1 d = 1/100 d = 1/1000	Permeation d = 1/100 d = 1/1000
	Microchem 4000 apron (Microgard) ▼	Permeation d = 1	Permeation d = 1	Permeation d = 1	-

▲: sampling times at t = 10; 30; 240 and 480 min; ▼: sampling times at t = 10 and 30 min.
E : PPE within the meaning of the PPE Directive; d : dilution; ¤ : identified in the IRSTEA study.

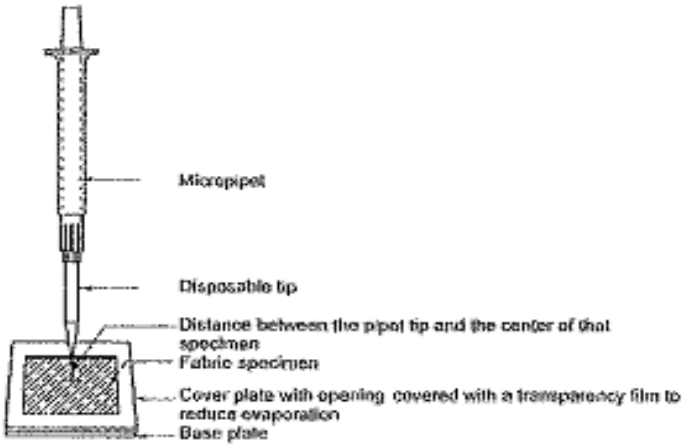
Table 4: Sampling plan for the equipment-clothing/plant protection preparations tested in the second test campaign

		Plant protection preparations tested						
		Sekoya (SC) Batch no: 59142 MA: 9700467	**Reldan 2M (EC)** Batch no: 16753905 MA: 2120086	**Traffic Allées (SC)** Batch no: 309011230 MA: 2020216	**Weedazol TL (CS)** Batch no: 311091574 MA: 6000067	**Anti-liseron/ Noverxone (SL)** Batch no: 311101927 MA: 2010139	**Success 4 (SC)** Batch no: P199287lbl05 MA: 2060098	**Opus (SC)** Batch no: 0006106503 MA: 9200020
		Analysis of fluazinam (500 g/L)	Analysis of chlorpyriphos-ethyl (225 g/L)	Analysis of isoxaben (55.6 g/L)	Analysis of aminotriazol (229 g/L)	Analysis of 2,4-D (100 g/L)	Analysis of spinosad (480 g/L)	Analysis of epoxiconazole (125 g/l)
Work clothing/protective clothing/PPE to be tested	Hoste cotton coverall (100% cotton); 350 g/m²	-	-	-	Penetration d = 1 d = 1/23	-	-	-
	Factory cotton coverall (65% polyester, 35% cotton); 245 g/m² ¤	Penetration d = 1 d = 1/500	Penetration d = 1 d = 1/375	-	-	-	Penetration d = 1 d = 1/5000	Penetration d = 1 d = 1/100
	Guy Cotten brand, 2 zip pro (65% polyester, 35% cotton); 280 g/m²	Penetration d = 1 d = 1/500	Penetration d = 1 d = 1/375	Penetration d = 1 d = 1/28 + 3 and 10 washes	-	Penetration d = 1 d = 1/50	Penetration d = 1 d = 1/5000 + 3 and 10 washes	Penetration d = 1 d = 1/100
	Biomidi brand 1 zip pro (65% polyester, 35% cotton); 300 g/m²	Penetration d = 1 d = 1/500	Penetration d = 1 d = 1/375	Penetration d = 1 d = 1/28 + 3 and 10 washes	-	Penetration d = 1 d = 1/50	Penetration d = 1 d = 1/5000 + 3 and 10 washes	Penetration d = 1 d = 1/100
	HEROS BLISTER brand (65% polyester, 35% cotton); 230 g/m²	Penetration d = 1 d = 1/500	Penetration d = 1 d = 1/375	Penetration d = 1 d = 1/28 + 3 and 10 washes	-	Penetration d = 1 d = 1/50	Penetration d = 1 d = 1/5000	Penetration d = 1 d = 1/100
	Tychem F apron-tunic Cat III – Type PB (3) (Dupont) E;¤ ▲	Permeation d = 1 d = 1/1000	Permeation d = 1 d = 1/1000	Permeation d = 1 d = 1/1000 Sampling time: 60 minutes only	-	Permeation d = 1 d = 1/1000 Sampling time: 60 minutes only	Permeation d = 1 d = 1/800 d = 1/5000	Permeation d = 1 d = 1/1000

▲: sampling time at t = 30 and 60 min
E : PPE within the meaning of the PPE Directive; d : dilution; ¤ : identified in the IRSTEA study.

In the absence of any harmonised standard, under the European Directive on PPE, for protective clothing worn by operators applying pesticides, ANSES relied on the ISO 27065 Standard published in 2011, "Protective clothing - Performance requirements for protective clothing worn by operators applying liquid pesticides", to ascertain the performance objectives for protective clothing.
The ISO 27065 Standard establishes minimum performance, classification and labelling requirements for protective clothing worn by operators applying liquid pesticide products diluted in water.
In this study, the testing standards used by ANSES for the penetration and permeation tests were those referenced in the ISO 27065 Standard, respectively the ISO 22608:2004 and EN ISO 6529:2001 Standards.

Penetration tests
The ISO 22608:2004 Standard, "Protective clothing - Protection against liquid chemicals - Measurement of repellency, retention, and penetration of liquid pesticide formulations through protective clothing materials" specifies a test method to measure repellency, retention and penetration of a known volume of liquid pesticide when applied to protective clothing material.
No external hydrostatic or mechanical pressure is applied to the test speciment during or after the application of the liquid pesticide.
The degree of contamination depends on numerous factors such as type of exposure, application technique, and pesticide formulation. As the level of exposure can vary considerably, this method is designed to rate relative performance of personal protective equipment (PPE) at two levels of contamination. Low level of contamination is achieved by applying 0.1 mL liquid formulation and high level by applying 0.2 mL. In the study, the high level of contamination was used.
This test method can be used to determine the resistance provided by protective clothing materials against penetration by different pesticide formulations. It does not measure resistance to permeation or degradation.
The ISO 22608:2004 Standard is applicable to the evaluation of materials that are new or those that have undergone treatment such as laundering, or simulated abrasion.



The study results are expressed for each plant protection preparation as follows:

Test results	Method A Gravimetric	Method B Analytical
Apparatus	Weighing scales	LC/MS LC/MS/MS
Contamination level	High (0.2 mL)	
Type of specimen	Material / Seams	
Retention rate Active ingredient	Mean Standard Deviation (µg)	Mean Standard Deviation (µg)
Repulsion rate Active ingredient	Mean Standard Deviation (µg)	Mean Standard Deviation (µg)
Penetration rate Active ingredient	Mean Standard Deviation (µg)	Mean Standard Deviation (µg)

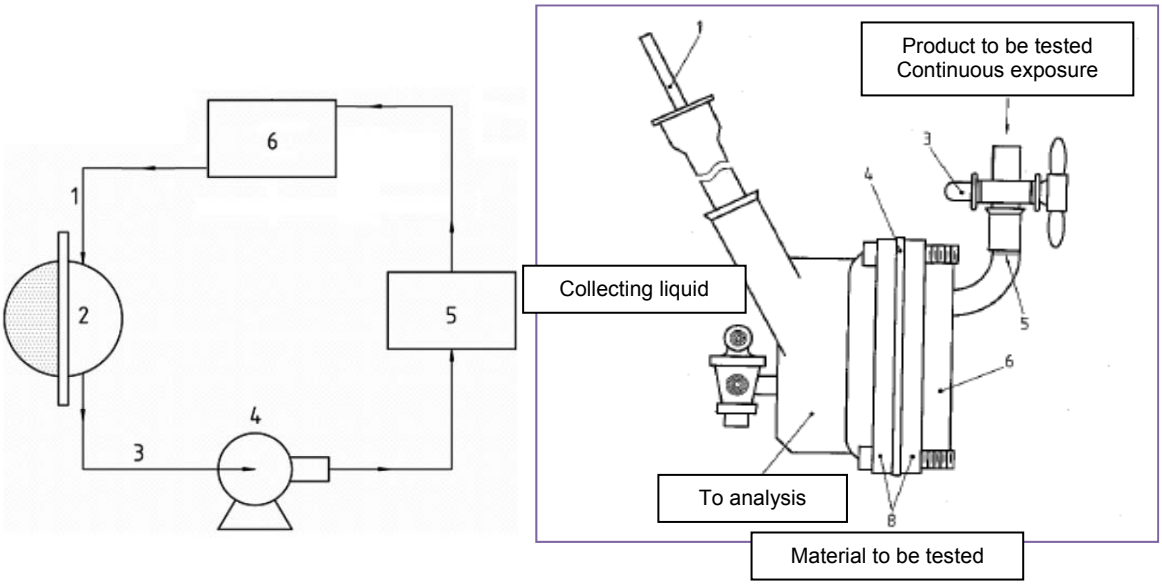
Permeation tests

An IFTH in-house test method was developed, based largely on the draft NF EN ISO 6529:2011 Standard: Protection against chemicals - Determination of resistance of protective clothing materials to permeation by liquids and gases, currently under discussion at European level.

This IFTH in-house test method is the MTD_132 (2012), developed as part of the present study to assess the performances of protective clothing against plant protection products with continuous contact and a quantitative batch analysis.
The principle is as follows: this is a test method for determining, for the materials used in protective clothing, resistance to permeation by liquid chemicals under conditions of continuous contact.
It is used to determine the resistance to permeation of the protective clothing material by plant protection products, at times predetermined by ANSES according to the conditions of use.

The study results are expressed for each plant protection preparation as follows:

Operating conditions	Type of circuit Type of collection medium Number of cell renewals Sampling times
Type of specimen	Material / Seams Thickness of each specimen
Cumulative permeation of active ingredient at each sampling time	Mean Standard Deviation (µg/cm^2)



Analytical methods

The analytical methods were developed based on reference standards for each of the active substances.

Repeatability tests were conducted with standard additions on an aqueous matrix.

Textile specimens were contaminated with a known quantity of active substance and then extracted with a suitable solvent. The extraction yield obtained had to be greater than 95% in order to rule on the choice of extraction solvent.

Development tests led to the following analytical conditions being established:

Compound to be analysed	Extraction technique	Analytical technique	Limit of quantification
2,4 D	Ultrasonic bath - Quality 1 water 2x30 min	LC/MS/MS UPLC/MS/DAD	10 µg/L
Isoxaben	Ultrasonic bath - Methanol 3x30 min	LC/MS/MS UPLC/MS/DAD	13 µg/L
Iprodione	Ultrasonic bath - Methanol 3x30 min	LC/MS/MS UPLC/MS/DAD	44 µg/L
Iprovalicarb	Ultrasonic bath - Methanol 3x30 min	LC/MS/MS UPLC/MS/DAD	13 µg/L
Fluazinam	Ultrasonic bath - Methanol 3x30 min	LC/MS/MS	20 µg/L
Chlorpyriphos-ethyl	Ultrasonic bath - Methanol 3x30 min	LC/MS/MS	37 µg/L
Aminotriazole	Mechanical shaking 200 rpm Quality 1 water 2x30 min	LC/MS/MS	10 µg/L
Spinosad	Ultrasonic bath - Methanol 3x30 min	LC/MS/MS	15 µg/L
Epoxiconazole	Ultrasonic bath Quality 1 water 2x30 min	LC/MS/MS	15 µg/L

2.2. Results

2.2.1. Penetration tests

Regarding the penetration tests, only the results obtained with the analytical method are shown, as this method is more accurate and robust than the gravimetric method, which corresponds to only one macroscopic pass of the product. The raw results are shown in detail in Tables 5 to 13 in Annex 2.

2.2.2. Permeation tests

The raw results are shown in detail in Tables 14 and 15 in Annex 3.

2.3. Analysis of results

2.3.1. Summary of penetration testing results

For the cotton/polyester and cotton **work clothing** without water-repellent treatment (Tables 5, 6 and 7 of Annex 1), there was no relationship between the basic weight of the fabric, the type of coverall and the dilution of the products, and the penetration indices. Accordingly, no general principle can be established. The penetration percentages obtained on the seams of the Molinel, Hoste and Factory work clothing with the Anti-liseron (*Anti-bindweed*), Traffic Allées, Rovral and Sirbel UD preparations are highly variable and lower than those obtained on the material.

For the **work clothing treated with the water-repellent coating**[15] (Tables 11, 12 and 13 of Annex 1), the penetration percentages were low with little variation. No relationship was observed between the basic weight of the fabric and the penetration index, with this depending mainly on the water-repellent coating. The work clothing treated with a water-repellent coating, tested with the Anti-liseron and Traffic Allées products, had much better penetration indices compared with untreated work clothing. Woven work clothing with a water-repellent coating had better repellent indices compared to untreated work clothing, whether the product was pure or diluted. After care cycles involving three washes and drying outdoors, the penetration percentages tended to increase, especially with diluted formulations. No relationship was observed between the basic weight of the fabric, the product tested and the penetration index. After care cycles involving 10 washes and drying outdoors, the penetration indices of work clothing treated with water-repellent coating increased significantly in certain test situations.

Concerning the PPE (Tables 8, 9 and 10 of Annex 2), the penetration percentages are almost zero, apart from the non-woven Tyvek Classic Cat III Type 5/6 and Tyvek Classic Plus Cat III Type 4/5/6 coveralls tested with the undiluted Anti-liseron formulation. The penetration percentages obtained on the PPE seams are higher than those obtained on the material of the Tyvek Classic Cat III Type 5/6 coverall, and similar to those obtained on the material of the Tyvek Classic Plus Cat III Type 4/5/6 and Tychem C Classic Cat III Type 3B/4/5/6 coveralls.

High variability was observed with the penetration tests. A greater number of measurements are therefore recommended.

2.3.2.Summary of permeation testing results

In the permeation tests on the materials and stitched/welded seams, the active substances found in the different plant protection preparations were analysed.

[15] With these three work coveralls treated with water-repellent coating, available on the market and tested for the study, no claim was made with regard to chemical protection, and the water-repellent treatment cannot therefore be considered as solely for chemical protection, as may be the case.

For the Tyvek Classic Plus Cat III Type 4/5/6 coverall (Table 14 of Annex 3), the results were highly variable. Significant breakthrough of active substances was observed on the material and seams of this coverall after 10 minutes of exposure to the undiluted Anti-liseron preparation. The coverall also exhibited significant breakthrough of active substances on the material and seams after 240 minutes of exposure to the diluted Rovral formulation. Cumulative permeation was not significant with the other preparations.

For the Tychem C Classic Cat III Type 3B/4/5/6 coverall (Table 15 of Annex 3), cumulative permeation obtained on the material and seams was not significant, except after 240 minutes of exposure to the diluted Rovral formulation.

Concerning the results of the permeation tests on the long-sleeved aprons, S Protec – Syngenta-Manulatex brand, and Microchem 4000 – Microgard brand, no significant breakthrough of active substances on the material and seams was observed with the undiluted Noverxone, Traffic Allées and Rovral Aqua Flo formulations at sampling times of 10 and 30 minutes.

Regarding the Tychem F - Dupont brand apron, no significant breakthrough of active substances on the material was observed with the undiluted and/or diluted Noverxone, Traffic Allées, Rovral Aqua Flo, Sirbel UD, Sekoya, Reldan 2M, Success 4 and Opus formulations at sampling times of 10 and 30 or 30 and 60 minutes, except for the undiluted Rovral Aqua Flo formulation, maximum 0.17 ± 0.24 µg/cm^2 and the undiluted Noverxone formulation, maximum 0.4 ± 0.5 µg/cm^2, for which breakthrough nevertheless remained negligible in terms of permeation percentage.

2.3.3.Conclusions on the performance tests

The results of the performance tests conducted according to the NF EN ISO 6529:2011 Standard (permeation test) show that:

- **the Category III Type 3 chemical protective clothing (1 coverall and 3 long-sleeved aprons),** offered a very high level of performance, with regard to resistance to permeation (material and seams for the coverall) of undiluted and/or diluted preparations (up to eight different preparations tested) at different sampling times, from 30 or 60 minutes for the tunics and up to 480 minutes for the coverall;

- **the Category III Type 4 coverall (material and seams)** offered a high level of performance except for two preparations (the undiluted form only for one product and the diluted form for the other), with regard to resistance to permeation, of four different undiluted and/or diluted preparations at different sampling times ranging up to 480 minutes.

The results of the performance tests conducted according to the ISO 22608:2004 Standard (penetration test) show that:

- **the Category III Type 3 coverall (material and seams)** offered a high level of performance (penetration %) with regard to resistance to penetration of undiluted and/or diluted preparations (four different preparations tested). No significant difference in performance was observed between the material and the seams;

- **the Category III Type 4 coverall (material and seams)** offered a high level of performance (penetration %), except for one undiluted preparation, with regard to resistance to penetration of undiluted and/or diluted preparations (four different preparations tested). No significant difference in performance was observed between the material and the seams;

- **the Category III Type 5,6 coverall (material and seams)** offered a high level of performance (penetration %) on the material, except for one preparation, with regard to

resistance to penetration of undiluted and/or diluted preparations (four different preparations tested). The performance level was lower on the seams;

- **the cotton/polyester and cotton (3 coveralls) work clothing (material and seams)** offered greatly varying (low to high) levels of performance (penetration %) on brand new coveralls (up to eight different preparations tested on one coverall), with regard to resistance to penetration of undiluted and/or diluted preparations. The performance level was generally higher on the seams;

- **The work clothing (material) treated with a water-repellent coating (3 coveralls[16]),** offered a high level of performance (penetration %) when brand new (six different preparations tested, undiluted and diluted), which was much better compared to work clothing without water-repellent treatment. After three and 10 washes (two preparations tested, undiluted and diluted), the penetration percentages increased in certain cases, especially after 10 washes.

Moreover, these results are comparable to those obtained by AFSSET in its 2010 report[17]. The three Category III Type 3 coveralls tested had a breakthrough time of more than 480 minutes for the three undiluted plant protection products used in the study. However, the Category III Type 4 coverall had a breakthrough time of more than 480 minutes for just one of the products, with the breakthrough time for the two other products being less than 30 minutes.

Regarding the Category III Type 3 PPE, based on the results of tests commissioned by AFSSET and ANSES, the performance in terms of resistance to permeation and penetration has consistently been identified as high.

For the other types of equipment, the performance in terms of resistance to penetration and/or permeation varied, from low to high. In addition, no relationship could be established between performance on the one hand, and coverall type, preparation type and product dilution on the other.

ANSES therefore believes, as it previously stated in its Opinion published in 2012[18], that in order to guarantee for operators that there is equipment available on the market with the required performances, the applicant must provide, for each product submitted for authorisation, the results obtained in penetration and permeation tests referenced according to the ISO 27065 Standard, or must justify an extrapolation from existing results.

One of the tested preparations, for which satisfactory levels of performance were obtained in the tests described above, was selected for a study of applicator exposure under real field conditions.

[16] With these three work coveralls treated with water-repellent coating, available on the market and tested for the study, no claim was made with regard to chemical protection, and the water-repellent treatment cannot therefore be considered as solely for chemical protection, as may be the case.

[17] *Efficacité de protection chimique des combinaisons de type 3 et de type 4. Constat de l'efficacité de protection chimique des combinaisons de type 3 et 4 au regard de la perméation* [Chemical protection effectiveness of Type 3 and Type 4 coveralls. Observation of the chemical protection effectiveness of Type 3 and Type 4 coveralls with regard to permeation] Request No 207/AC018. Scientific and technical support report, January 2010.

[18] Avis de l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail relatif à une demande d'informations complémentaires aux avis délivrés par l'Anses concernant les caractéristiques des EPI (Equipement de Protection Individuelle). [Opinion of the French Agency for Food, Environmental and Occupational Health & Safety on a request for additional information to the Opinions issued by ANSES concerning the characteristics of PPE (Personal Protective Equipment)] Request No 2012-SA-0222. 29 October 2012. https://www.anses.fr/fr/documents/DPR2012sa0222.pdf

3. Study of exposure of operators wearing work clothing and chemical protective clothing in a wine growing environment

To supplement the results from the permeation and penetration laboratory tests, ANSES commissioned an experimental exposure study from STAPHYT, a company specialising in this type of study and qualified to conduct it according to Good Laboratory Practice (GLP). The aim of this study, conducted according to GLP and OECD guidelines[19], was to assess the protective factors conferred by certain PPE and work clothing when actually used in conditions representative of the field. This equipment had already undergone performance testing in the laboratory as part of the previous study. For this, the dermal exposure of operators wearing this PPE and work clothing was determined during the mixing-loading, application and spraying equipment cleaning phases.

3.1. Materials and Methods

The study was conducted in August 2013 on one of the preparations (Success 4) tested previously during the performance tests. The preparation, containing spinosad, was applied to vines with an air-assisted sprayer at a dose of 50 g/ha.
The study involved 15 male farmers working on 13 holdings in the south of France, more specifically in the Pyrénées Orientales (*département* 66), Hérault (*département* 34) and Aude (*département* 11). The choice of these holdings was based on the availability of farmers prepared to take part in such a study in the month of August, at short notice with regard to the study's reporting deadlines. The interest of the study lay in the fact that the observations and measurements were made in the field under real conditions, according to GLP rules, and that the study was publicly funded, ensuring its independence. Moreover, the levels of contamination determined in this study can be regarded as comparable to those obtained in the study by Groβkopf *et al*. (2013) on the compilation of data, which was used to propose the model (Agricultural Operator Exposure Model).

The farmers mainly carried out mixing-loading and application tasks, but 10 operators also cleaned their spraying equipment at the end of the working day. Twelve out of 15 tractors had a cabin fitted with a filter, and different types of air-assisted sprayers were used.

The different parameters used in the study for the mixing-loading and application phases are summarised below:

- Average concentration of active substance in the solution: 0.377 g/L (from 0.240 to 0.747 g/L)
- Average duration of the mixing-loading phase: 11 min (from 2 to 21 min)
- Average spray volume applied by operator: 1605 L/operator (from 880 to 3200 L)
- Average amount of active substance applied: 581 g/operator (from 288 to 1200 g)
- Average application volume: 144 L/ha (from 96 to 213 L/ha)
- Average duration of the application phase (including cleaning): 294 min (from 178 to 442 min)
- Average duration of the cleaning phase: 20 min (from 4 to 46 min)
- Average surface area treated: 11 ha (from 6 to 24 ha)

Dermal exposure was measured using the "whole-body dosimeter" method: operators wore new working clothes that had been washed three times and PPE that was used as the sampling medium. Following exposure, this sampling medium was analysed to determine the concentration of active substance deposited on the body. Exposure of hands was measured according to the same principle: gloves were worn by the operators, and the compounds were then assayed on these gloves.

The hands, head and neck were also washed with a solvent after the work; this solvent was then recovered and the dislodged active substances in it were assayed. Inhalation exposure was not measured in this study, as it is regarded as a minor source of exposure compared to the dermal route.

[19] Series on Testing and Assessment No. 9. Guidance Document for the Conduct of Studies of Occupational Exposure to Pesticides During Agricultural Application.

External dosimeters were used in the study to measure potential body exposure, with a 65% polyester/35% cotton work coverall with a basic weight of 280 g/m^2 treated with water-repellent coating, and Category III Type PB (3) partial PPE worn over the aforementioned coverall during the mixing-loading and cleaning (when this was carried out) phases.
An internal dosimeter was also used in the study to measure actual body exposure. This is a long cotton undergarment that covers the arms, legs and torso, worn underneath the work coverall.

EN 374-3 certified nitrile gloves were used to measure potential hand exposure, with hand washing enabling actual exposure to be measured. Face and neck washing enabled head exposure to be measured.
The amounts of spinosad deposited on these dosimeters and found in the washing solvents were determined by liquid chromatography according to the analytical methods developed and validated at Eurofins Agroscience Services Chem SAS.

3.2. Results

Actual dermal exposure (ADA) was measured by the sum of the quantities of active substances found on the undergarments and in the washing water (head/neck and hands).
Potential dermal exposure (PDE) corresponds to the sum of the quantities of active substances found on all the work clothing/PPE used, the undergarments and the washing water.
Potential dermal exposure was mainly measured on the Category III and Type PB (3) partial PPE during the mixing-loading phase (36% of PDE), followed by the work coverall (24.9% of PDE) then by the Category III and Type PB (3) partial PPE during the cleaning phase (15.4% of PDE). It was also measured on the gloves (21% of PDE) and by hand washing (1.9% of PDE).
Actual exposure of hands accounted for 85% of total actual dermal exposure.
The results are summarised in the tables below.

Operator exposure in (µg/kg a.s. applied)

	Exposure (µg/kg a.s.° applied)			
	PDE without hands *	ADE without hands **	PDE $	ADE $$
Min.	1,827	1.35	2,358	51.3
75th percentile	19,066	83.2	26,722	447
95th percentile	32,675	209	38,179	888
Max.	41,358	305	44,965	1,445
Nb replicates	15	15	15	15

PDE: potential dermal exposure.

ADE: actual exposure.

°a.s.: active substance.

°°b.w.: body weight.

*: M/L apron + cleaning apron + polyester/cotton coverall + undergarments + head/neck washing.

**: undergarments + head/neck washing.

#: gloves + hand washing.

##: hand washing.

$: M/L apron + cleaning apron + polyester/cotton coverall + undergarments + head/neck washing + gloves + hand washing.

$$: undergarments + head/neck washing + hand washing.

Operator exposure in (µg/kg b.w.)

	Exposure (µg/kg b.w.°°)

	PDE without hands *	ADE without hands **	PDE $	ADE $$
Min.	10.5	0.00722	13.6	0.563
75th percentile	136	0.671	178	2.74
95th percentile	255	1.51	301	6.64
Max.	316	3.33	385	8.16
Nb replicates	15	15	15	15

See previous table for key

The following photographs taken during the study in different holdings show the three phases (mixing-loading, application and cleaning).

Mixing-loading phase

Application phase

Cleaning phase

The protective factor associated with the work coverall used (65% polyester/35% cotton with a basic weight of 280 g/m^2 treated with water-repellent coating) is 98.5% (75th percentile) and 94.9% (95th percentile). When Category III Type PB (3) partial PPE is combined with the coverall (mixing-

loading phase, and cleaning phase when this took place) the level of protection reaches 99.5% (75th percentile) and 98.7% (95th percentile).

	Protective factor (%)	
	75th percentile	95th percentile
65% polyester/35% cotton, 280 g/m^2 work coverall	98.5	94.9
Category III Type PB (3) partial PPE + 65% polyester/35% cotton, 280 g/m^2 work coverall	99.5	98.7

4. Summary of results of laboratory tests and field tests on performance of PPE and work clothing

The different results presented above make it possible to draw various lessons concerning the main PPE and work clothing distributed in France and often recommended by applicants in their MA applications.

Performance of the main PPE and work clothing tested

- The long-sleeved tunic certified as Cat III (PB) Type 3 and recommended during the mixing-loading and cleaning phases: the results of the exposure test conducted in the vineyard show that this partial PPE can protect operators under actual conditions of use. In addition, it offered high resistance to permeation and penetration in the tests conducted according to the ISO 22608:2004 and ISO 6529:2001 Standards over representative durations of use.
  It therefore seems appropriate to recommend the use of the long-sleeved tunic certified as Cat III Type 3 during the mixing-loading and cleaning phases.

  Priority should be given to determining the measures to manage this PPE with regard to decontamination by washing after use, storage and information on when to renew equipment.

- The Cat III Type 3 coverall with hood recommended for manual spraying in greenhouses on high- or low-growing crops during application if contact with vegetation is intense: the results from the performance tests showed high resistance to permeation. This type of coverall may be used for situations of very high exposure and in the absence of alternative methods of application. It should be noted that because comfort is reduced, wearing of this PPE can only be considered for a limited period in the day. The priority actions to be taken are similar to those for the long-sleeved tunic certified as Cat III Type 3.

- The Cat III Type 4 coverall with hood recommended for manual spraying in open fields or greenhouses on high-growing crops during application if contact with vegetation is not intense, but also during application with a mounted or towed sprayer (air-assisted or air-blast) without a cabin: the results of tests on resistance to permeation varied greatly. In addition, it should be noted that there are very few data on exposure, especially for backpack sprayers in open fields for high-growing crops. To gain a better understanding of the protection provided by this type of coverall, ANSES commissioned a study to quantify operator exposure during application with a backpack sprayer in vines. The results will be available in 2015. To ensure the performance of this PPE, the tests should be conducted for each preparation undiluted and diluted to the maximum operational dilution.

- The work coverall with water-repellent coating recommended during application with a mounted or towed sprayer (air-assisted or air-blast) with a cabin: the performance test results showed high resistance to penetration, with a reduction in performance according to the number of washes. It should be noted that the field study conducted in the vineyard with a pre-washed coverall, under actual conditions of use, demonstrated a high protective factor. The protective factor obtained from this study confirm what has been identified in numerous exposure studies with non-water-repellent work coveralls and is consistent with the protective factors proposed by EFSA in its 2014 draft

guidance document. Nevertheless, to ensure the performance of the equipment, tests will have to be conducted for each preparation undiluted and diluted to the maximum operational dilution.

Parameters taken into account by ANSES for the risk assessment

Polyester/cotton work coveralls were the clothing mainly worn in the various studies conducted in Europe to determine operator exposure and which led to the establishment of the exposure models used in the context of the risk assessment.

Various analyses[20] of the studies submitted in the context of marketing authorisation applications and of those published in the literature, as well as a comparison between these two sources of data[21], show that work coveralls do provide a certain level of protection to operators. Some variability can however be observed in the values of the protective factors.

It should be noted that an analysis of the level of protection of work coveralls and certified coveralls is planned, as part of the European BROWSE[22] research project.

Relying on the data available, in the latest version of its draft guidance document[23], EFSA proposes the following values with regard to protective factors for the body:
Extract from Table 7 of EFSA's draft guidance document:

	Penetration factor (by which exposure in absence of protection should be multiplied)	Specific exposure value affected
Uncertified work clothing	Operators: 10%	Dermal exposure of body
Certified coverall	Operators: 5%	Dermal exposure of body

These protective factors are currently taken into account for the assessments conducted by ANSES.
However, the experimental data on which these protective factors are based do not always enable the protective factor to be associated with certainty with a type of equipment or clothing available on the market at national level. Moreover, when reference is made to a means of protection, compliance with the regulations in force[24] is required.

[20] The documents mentioned below represent the most exhaustive analyses; they may be sector-specific depending on the type of application.
-Gerritsen-Ebben R, Brouwer D H, van Hemmen JJ. Effective Personal Protective Equipment (PPE). Default setting of PPE for registration purposes of agrochemical and biocidal pesticides. TNO report, January 8, 2007.
-Großkopf C, Mielke H, Westphal D, Erdtmann-Vourliotis M, Hamey P, Bouneb F, Rautmann D, Stauber F, Wicke H, Maasfeld W, Salazar JD, Chester G and Martin S, 2013. A new model for the prediction of agricultural operator exposure during professional application of plant protection products in outdoor crops. J. Verbr. Lebensm. (2013) 8:143–153.
-Driver J, Ross J, Mihlan G, Lunchick C, Landenberger B. Derivation of single layer clothing penetration factors from the pesticide handlers exposure database. Regulatory Toxicology and Pharmacology 2007;49:125-137.
-*Etudes et modèles pouvant être utilisés pour estimer l'exposition des opérateurs lors d'une utilisation d'un produit phytopharmaceutique en zones non agricoles* [Studies and models that can be used to estimate operator exposure during use of a plant protection product in non-agricultural areas] Collective Expert Report. Expert Committee on Plant protection products: chemical substances and preparations. Version 2 - September 2012. http://www.anses.fr/Documents/DPR-Ft-DocumentZNA.pdf

[21] "Project to assess current approaches and knowledge with a view to develop a Guidance Document for pesticide exposure assessment for workers, operators, bystanders and residents".
EFSA AGREEMENT NUMBER EFSA/PPR/2007/01 FINAL REPORT. 28 NOVEMBER 2008."
http://www.efsa.europa.eu/en/scdocs/doc/26e.pdf

[22] BROWSE available from https://secure.fera.defra.gov.uk/browse/index.cfm

[23] Guidance on the assessment of exposure of operators, workers, residents and bystanders in risk assessment for plant protection products. EFSA (2014).

[24] Council Directive89/686/EEC of 21 December 1989 on the approximation of the laws of the Member States relating to personal protective equipment.

Performance level and protective factor

In light of the information above, ANSES had already stated in an Opinion published in 2012[25] that, to enable the Agency to verify for each product the existence of equipment available on the market with the required performance, it will be necessary to incorporate in the regulations the requirement for the applicant to provide test results for PPE available on the market, capable of confirming, on the basis of standardised tests, that the performance objectives required for protective equipment have been achieved for the product in question. An extrapolation from results on PPE performance between different preparations may be considered on a case-by-case basis. It is important to clearly distinguish the notion of protective factor from that of performance. Testing under standards aiming to determine performance cannot reproduce actual conditions of use of PPE and the level of protection offered. It is also important to distinguish between the notions of performance level according to the standard, and protection level at the work station, because the constraints of the work activity are important factors to be considered when choosing equipment that can offer a satisfactory level of protection and actually be worn[26].

In the absence of any harmonised standard under the European Directive on PPE for protective clothing worn by operators applying pesticides, ANSES had recommended in its Opinion the use of the ISO (27065) Standard published in 2011, *"Protective clothing - Performance requirements for protective clothing worn by operators applying liquid pesticides"* to ascertain the performance objectives for protective clothing. More specifically, the tests should be conducted with the preparation undiluted and at the maximum dilution in the spray solution. The ISO (27065) Standard incorporates two test standards on penetration (ISO 22608:2004) and permeation (ISO 6529:2001).

These two laboratory methods are useful for verifying and classifying the performance of the materials, although they cannot be used to determine the protective factors. However, if the performances of the constituent materials of the coveralls are comparable, according to the ISO 22608:2004 and/or ISO 6529:2001 Standards, the protective factors should not differ significantly under the same conditions of use. In the context of the ISO 27065:2011 Standard, based on testing conducted according to the penetration or permeation tests, several performance levels may be claimed (levels 1 or 2 when using the ISO 22608:2004 Standard, level 3 when using the ISO 6529:2001 Standard). Using the ISO 22608 Standard could help with the certification of work coveralls.

V. GENERAL CONCLUSION AND RECOMMENDATIONS

Reminder of the importance of general principles of prevention

The Agency's internal request focused on the effectiveness of personal protective clothing and equipment worn by applicators of plant protection products. It is however important to begin by reiterating that in terms of prevention, according to the general principles of the Labour Code, **the first measure to be taken involves removing the hazard at the source.** This is followed by replacing what is hazardous by something that is safe or is less hazardous. When this is not possible, **collective protective measures should be preferred.** The use of suitable, well-

[25] Avis de l'Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail relatif à une demande d'informations complémentaires aux avis délivrés par l'Anses concernant les caractéristiques des EPI (Equipement de Protection Individuelle). [Opinion of the French Agency for Food, Environmental and Occupational Health & Safety on a request for additional information to the Opinion issues by ANSES concerning the characteristics of PPE (Personal Protective Equipment)] Request No 2012-SA-0222. 29 October 2012. https://www.anses.fr/fr/documents/DPR2012sa0222.pdf

[26] *Les équipements de protection individuelle. Règles d'utilisation*. Isabelle Balty, Annie Chapouthier. INRS, 2013. http://www.inrs.fr/accueil/produits/mediatheque/doc/publications.html?refINRS=ED%206077

maintained equipment (tractors and cabins, spraying methods and equipment, etc.) is crucial, before implementing additional protection such as personal protective measures.

Various organisations have conducted work on collective protection, but this needs to be pursued in greater depth and updated, and the amount and robustness of data for measuring the level of protection that these collective measures actually provide needs to be increased, **to enable them to be taken into account in the models used in the European regulatory framework to estimate operator exposure.** This would help prioritise the use of collective protection measures, with personal protective measures being added where appropriate, in the context of opinions and decisions on marketing authorisations for plant protection products.

It should also be reiterated that other measures are also important for avoiding or reducing potential exposure, in particular: **adapting the work station**, **adapting the packaging of preparations** and opting for preparation types that limit exposure in order to reduce operator exposure during preparation of the spray solution. It should be noted that some measures are being addressed as part of the Ecophyto plan and have been introduced by some applicants, especially regarding packaging.

Main findings on the availability and effectiveness of clothing and PPE, as well as practices

The various studies undertaken, while not claiming to cover every situation, help to update the conclusions that can be drawn concerning the PPE and work clothing available on the market, their performance in terms of user comfort and level of protection, and the practices in the field.

It has been found that **there is a fairly diverse range of work clothing and PPE,** enabling solutions adapted to many exposure situations during the different work phases (in particular mixing/floading, application and cleaning) to be offered in the distribution channels for the agricultural sector.

The surveys conducted show however that while work clothing is widely used, **PPE is not always worn** during work phases in which it is nonetheless a condition of the marketing authorisation for the products involved. In addition, one survey shows that PPE sold for "single use" is sometimes reused by users. The surveys also show that while progress has been made in terms of making farmers more aware of the importance of protecting themselves from exposure to products, especially through Certiphyto training, **significant efforts still need to be made** towards this goal. It is essential to note that risk assessment is based on exposure data that reflect actual conditions: in this regard, the PPE may be recommended and must actually be worn to ensure operator safety. The findings that can be drawn from the surveys with regard to the wearing of PPE should lead to **measures being stepped up, within a short time frame, to train and raise awareness among operators when using plant protection products.**

The results of laboratory testing that are summarised in Part IV of this Opinion show that **there is PPE available on the market that offers a high level of performance,** both in terms of penetration and permeation. The field study conducted also confirms that the level of protection observed in real conditions is consistent with the parameters taken into account when applying the exposure models used in the regulatory assessment of products, which are included in an EFSA guide currently being published.

Nevertheless, the coveralls certified as PPE, which offer good performance in terms of penetration and permeation, largely correspond to protective clothing whose level of comfort is deemed mediocre, poor or very poor by farmers, and their use therefore requires a detailed job analysis. The partial PPE, such as the long-sleeved tunic, which can be used for certain activities, performs well and has a good level of comfort.

The work clothing for low-exposure situations seems more suitable for the application of products, in terms of user comfort, but the results of laboratory tests show that the performance levels vary from one product to the next. The use of work coveralls that have been treated with water-repellent

coatings seems interesting as a means of significantly increasing resistance to penetration by products, but it would require precise instructions to be developed on the washing and care of these clothes. In any event, **the use of these work clothes as a means of protection requires standards to be validated on the basis of which their performance can then be certified.**

The Agency's recommendations

It should first be noted that, in accordance with its Opinion published in October 2012, **the Agency now systematically asks manufacturers to provide, in their applications for marketing authorisation of a plant protection product, precise information on the types of PPE and/or work clothing they consider appropriate** for the protection of workers and operators, with regard to the product in question. On this basis, ANSES examines the applications and specifies in its opinions the PPE and/or work clothing required.

To ensure the systematic and standardised provision of precise data by the applicant, it is necessary to be able to state which standards will be used as a basis for the performance tests to be conducted. In the context of the aforementioned Opinion, and pending more specific standards, the Agency proposed **relying on the penetration and permeation tests stipulated in the ISO 27065 Standard** published in 2011, entitled "Protective clothing - Performance requirements for protective clothing worn by operators applying liquid pesticides".

The Agency is therefore encouraging the continuation and completion of the standardisation work that was recently reactivated at European level, on France's initiative, so as to **achieve the systematic certification of PPE used for the protection from occupational exposure to plant protection products, including work coveralls,** which are widely used and play a valuable role in protecting applicators.

On this basis, it is necessary to **ask PPE manufacturers, alongside the CE certification of their equipment, to provide all information relevant to users** on the performance of their equipment depending on the use, and on the best practices to be observed regarding care of this equipment (washing, storage, reuse, etc.).

The Agency also recommends that, given the variations in PPE performance observed between products, **applicants should be asked to provide, for each product submitted for authorisation, the results of tests on the PPE they are recommending, conducted with their product according to the harmonised standards available** (and pending their availability, according to a protocol based on the standards work under way); or to justify extrapolation from existing results on products with similar characteristics. These requirements should be **applied at European level** in order to harmonise practices within Europe.

Moreover, personal protective equipment (PPE) must be appropriate to the risks involved, as well as adapted to the user and compatible with the activity to be performed. Analysing the job and the work activity provides essential information for guiding the choice of protective measures. In general, **the information resulting from the risk assessment and the recommendations on prevention should be examined and adapted to the characteristics of the work station, under the farmer's responsibility.** In the agricultural context, in which the work can be physically intense, handling constraints, requirements for ease of movement, dexterity and a comfortable temperature should be especially taken into account.

With regard to information and training in field practices, **ANSES recommends that new initiatives be taken to raise awareness among all farmers of the health issues and convince them of the need to strictly comply with the wearing of PPE** as specified by the products' conditions for use. In this regard, **the Agency recommends the adoption and widespread distribution of good practice guides for each sector.** These guides could draw on existing documents, in particular those from the Agricultural Mutual Benefit Society (MSA) or technical centres.

They could be used as a reference by risk prevention advisers and the farmers themselves, among others. They will need to take account of specific crops, conditions of use and equipment used, and should also incorporate collective and personal protection, ergonomics, and rules to limit exposure such as standard hygiene practices and procedures for use.

Lastly, ANSES reiterates that alongside the work presented in the context of this Opinion, a group of experts devoted to the study of **exposure of agricultural workers to pesticides** has been set up. It is primarily aiming to establish an inventory of the scientific data available on levels of occupational exposure in different exposure situations. This work seeks to identify potential needs for further studies and research to address the observed lack of data for documenting certain exposure situations. This expert group should submit the results of its work in early 2015.

Marc MORTUREUX

Annex 1: chemical protective clothing and standards according to the INRS document[27]

Protective clothing against chemical risks is the subject of numerous European and international standards (or draft standards). These define six types of clothing according to the risks of exposure.

These standards describe the tests that must be performed on the clothing, as well as the performance levels that must be achieved by the textiles used or the clothing as a whole. These standards propose a classification for the performance measurements, and the performance class is represented by a number. The higher the number, the better the performance.

The CE symbol and the symbols displayed on the clothing or packaging certify that the clothing is compliant with the minimum safety requirements. Within each type of clothing, it is important to verify that the performance classes correspond to the risk assessment. Preference should be given, wherever possible, to the highest classes.
Symbol appearing on protective clothing against chemical risks:

The six types of standardised clothing

Type 1: Gas-tight chemical protective coverall. This clothing includes a breathable air supply that may be, for example, a self-contained, open-circuit, compressed-air breathing apparatus worn inside (type 1a) or outside (type 1b) the chemical protective suit, or a breathable air system providing positive pressure (type 1c).

Type 2: Non-gas-tight chemical protective suit, with a breathable air system providing positive pressure.

Type 3: Liquid-tight chemical protective clothing, resistant to penetration by liquids in the form of a continuous jet.

Type 4: Clothing **impermeable to mists**, i.e. resistant to penetration of sprayed liquids;

Type 5: Chemical protective clothing **resistant to penetration by solid particles**.

Type 6: Clothing intended for risks associated with **accidental exposure** to limited sprays or splashes of low-hazard chemicals.

Reusable clothing is distinguished from single-use clothing, which may also be described as for "short-term use" or "limited lifespan".

[27] INRS. Practical safety data sheet, ED 127. *Quels vêtements de protection contre les risques chimiques ?* [What protective clothing can be worn against chemical risks?] 2008.
http://www.inrs.fr/accueil/produits/mediatheque/doc/publications.html?refINRS=ED%20127

Annex 2: Results of the penetration tests

In the tables, the amount of active ingredient present is found in three levels corresponding to:

- For layer 1 (above the material to be tested), the percentage of active substance collected by a filter paper, and characterised by the repellent index;
- For layer 2 (the material to be tested), the percentage of active substance in the material, and characterised by the adsorption index;
- For layer 3 (below the material to be tested), the percentage of substance that has passed through the material and been collected by a filter paper, and characterised by the penetration index;

Table 5: Reference tested: Polyester/cotton coverall (40/60) – Molinel brand 310 g/m^2

			Percentage calculated from the total quantity of active substance found on each layer						
			Anti-liseron d:1	Anti-liseron d:1/50	Traffic Allées d:1	Traffic Allées d:1/28	Rovral Aqua Flo d:1	Rovral Aqua Flo d:1/667	Sirbel UD d:1/115
Repellent index (%)	Material	Mean	0.2	0.0	37.4	0.0	77.6	0.0	0.3
		Standard Deviation	0.2	0.0	2.0	0.0	2.3	0.0	0.6
Adsorption index (%)		Mean	95.0	24.5	62.6	67.9	22.4	39.2	84.1
		Standard Deviation	8.4	11.8	2.0	28.4	2.3	27.7	26.6
Penetration index (%)		Mean	4.8	75.5	0.0	32.1	0.0	60.8	15.6
		Standard Deviation	8.2	11.8	0.0	28.4	0.0	27.7	26.9
Repellent index (%)	Seams	Mean	0.1	6.1	0.0	0.2	48.5	0.0	0.4
		Standard Deviation	0.0	8.6	0.0	0.3	42.2	0.0	0.6
Adsorption index (%)		Mean	93.5	93.9	100.0	81.5	51.5	65.6	91.1
		Standard Deviation	10.9	8.6	0.0	31.6	42.2	35.3	14.5
Penetration index (%)		Mean	6.4	0.0	0.0	18.3	0.0	34.4	8.5
		Standard Deviation	10.9	0.0	0.0	31.8	0.0	35.3	14.8

Table 6: Reference tested: Cotton coverall – Hoste brand 350 g/m^2

			Percentage calculated from the total quantity of active substance found on each layer						
			Anti-liseron d:1	Anti-liseron d:1/50	Traffic Allées d:1	Traffic Allées d:1/28	Rovral Aqua Flo d:1	Rovral Aqua Flo d:1/667	Sirbel UD d:1/115
Repellent index (%)	Material	Mean	0.0	0.0	0.5	0.0	0.2	0.0	0.0
		Standard Deviation	0.0	0.0	0.4	0.0	0.3	0.0	0.0
Adsorption index (%)		Mean	71.4	69.6	53.0	73.5	35.3	43.7	74.7
		Standard Deviation	9.5	9.2	1.6	5.0	10.1	12.9	3.4
Penetration index (%)		Mean	28.6	30.4	46.4	26.5	64.5	56.3	25.3
		Standard Deviation	9.5	9.2	1.5	5.0	9.9	12.9	3.4
Repellent	Seams	Mean	0.0	0.0	0.0	0.0	0.2	0.0	0.0

			Percentage calculated from the total quantity of active substance found on each layer						
			Anti-liseron d:1	Anti-liseron d:1/50	Traffic Allées d:1	Traffic Allées d:1/28	Rovral Aqua Flo d:1	Rovral Aqua Flo d:1/667	Sirbel UD d:1/115
index (%)		Standard Deviation	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Adsorption index (%)		Mean	100.0	100.0	96.1	98.8	63.4	100.0	96.1
		Standard Deviation	0.0	0.0	3.7	2.1	21.3	0.0	6.8
Penetration index (%)		Mean	0.0	0.0	3.8	1.2	36.4	0.0	3.9
		Standard Deviation	0.0	0.0	3.7	2.1	21.3	0.0	6.8

			Percentage calculated from the total quantity of active substance found on each layer	
			Weedazole d:1	Weedazole d:1/23
Repellent index (%)	Material	Mean	0.03	13.9
		Standard Deviation	0.01	22.4
Adsorption index (%)		Mean	84.4	78.0
		Standard Deviation	2.6	19.4
Penetration index (%)		Mean	15.6	8.1
		Standard Deviation	2.6	12.6

Table 7: Reference tested: Polyester/cotton coverall (65/35) – Factory brand 245 g/m^2

			Percentage calculated from the total quantity of active substance found on each layer						
			Anti-liseron d:1	Anti-liseron d:1/50	Traffic Allées d:1	Traffic Allées d:1/28	Rovral Aqua Flo d:1	Rovral Aqua Flo d:1/667	Sirbel UD d:1/115
Repellent index (%)	Material	Mean	0.0	0.4	49.9	0.0	44.4	0.5	0.0
		Standard Deviation	0.0	0.1	3.1	0.0	9.7	0.9	0.0
Adsorption index (%)		Mean	57.2	88.2	48.4	62.5	55.6	27.9	95.8
		Standard Deviation	17.4	19.2	2.3	22.7	9.6	19.5	7.3
Penetration index (%)		Mean	42.7	11.4	1.7	37.5	0.0	71.6	4.2
		Standard Deviation	17.4	19.1	2.0	22.7	0.0	18.8	7.3
Repellent index (%)	Seams	Mean	0.1	0.3	0.1	0.0	29.2	3.0	0.0
		Standard Deviation	0.0	0.1	0.1	0.0	9.5	5.3	0.0
Adsorption index (%)		Mean	98.2	82.4	99.7	92.9	70.8	76.3	100.0
		Standard Deviation	1.6	20.1	0.6	12.3	9.5	33.5	0.0
Penetration index (%)		Mean	1.8	17.3	0.2	7.1	0.0	20.7	0.0
		Standard Deviation	1.6	20.1	0.4	12.3	0.0	35.8	0.0

Percentage calculated from the total quantity of active substance found on each layer

			Sekoya d:1	Sekoya d:1/500	Reldan 2M d:1	Reldan 2M d:1/375	Success 4 d:1	Success 4 d:1/5000	Opus d:1	Opus d: 1/100
Repellent index (%)	Material	Mean	28.2	2.0	0.0	3.7	29.0	1.0	15.4	0.0
		Standard Deviation	21.3	0.5	0.0	0.6	16.3	0.6	24.9	0.0
Adsorption index (%)		Mean	54.5	59.3	73.4	62.8	71.0	73.4	46.2	57.4
		Standard Deviation	13.2	11.5	6.5	2.2	16.3	21.9	7.8	26.6
Penetration index (%)		Mean	17.3	38.6	26.6	33.5	0.0	25.6	38.4	42.6
		Standard Deviation	14.4	12.0	6.5	2.6	0.0	21.7	32.0	26.6

Table 8: Reference tested: Tyvek Classic Cat III, Type 5,6 coverall – Dupont brand

			Percentage calculated from the total quantity of active substance found on each layer						
			Anti-liseron d:1	Anti-liseron d:1/50	Traffic Allées d:1	Traffic Allées d:1/28	Rovral Aqua Flo d:1	Rovral Aqua Flo d:1/667	Sirbel UD d:1/115
Repellent index (%)	Material	Mean	23.1	99.2	97.3	92.0	86.7	75.2	79.1
		Standard Deviation	22.0	0.3	0.5	2.0	2.8	7.5	4.4
Adsorption index (%)		Mean	59.8	0.6	2.7	8.0	13.1	24.8	20.9
		Standard Deviation	23.1	0.1	0.5	2.0	2.6	7.5	4.4
Penetration index (%)		Mean	17.1	0.2	0.0	0.0	0.2	0.0	0.0
		Standard Deviation	22.2	0.3	0.0	0.0	0.2	0.0	0.0
Repellent index (%)	Seams	Mean	32.4	62.0	57.0	35.4	56.8	60.3	34.9
		Standard Deviation	20.2	54.0	37.6	30.8	13.6	9.1	30.3
Adsorption index (%)		Mean	63.5	15.5	38.5	57.4	41.6	39.7	57.1
		Standard Deviation	17.9	16.6	29.8	18.4	14.1	9.1	16.4
Penetration index (%)		Mean	4.1	22.4	4.6	7.3	1.6	0.0	8.0
		Standard Deviation	7.0	38.0	7.9	12.6	2.3	0.0	13.9

Table 9: Reference tested: Tyvek Classic Cat III, Type 4,5,6 coverall – Dupont brand

			Percentage calculated from the total quantity of active substance found on each layer						
			Anti-liseron d:1	Anti-liseron d:1/50	Traffic Allées d:1	Traffic Allées d:1/28	Rovral Aqua Flo d:1	Rovral Aqua Flo d:1/667	Sirbel UD d:1/115
Repellent index (%)	Material	Mean	55.5	99.6	96.7	88.9	79.8	83.6	83.2
		Standard Deviation	30.7	0.2	2.4	1.7	3.1	3.9	1.6
Adsorption index (%)		Mean	37.0	0.4	3.3	11.1	20.2	16.4	16.8
		Standard Deviation	24.1	0.2	2.4	1.7	3.1	3.9	1.6
Penetration index (%)		Mean	7.5	0.0	0.0	0.0	0.0	0.0	0.0
		Standard Deviation	7.4	0.0	0.0	0.0	0.0	0.0	0.0
Repellent index (%)	Seams	Mean	56.3	99.0	97.7	78.1	92.3	71.6	43.1
		Standard Deviation	48.6	0.6	0.7	18.3	4.8	12.0	37.9

			Percentage calculated from the total quantity of active substance found on each layer						
			Anti-liseron d:1	Anti-liseron d:1/50	Traffic Allées d:1	Traffic Allées d:1/28	Rovral Aqua Flo d:1	Rovral Aqua Flo d:1/667	Sirbel UD d:1/115
Adsorption index (%)		Mean	38.1	1.0	2.3	21.9	7.6	28.4	56.9
		Standard Deviation	39.1	0.6	0.7	18.3	4.7	12.0	37.9
Penetration index (%)		Mean	5.6	0.0	0.0	0.0	0.1	0.0	0.0
		Standard Deviation	9.6	0.0	0.0	0.0	0.1	0.0	0.0

Table 10: Reference tested: Tychem C Classic Cat III, Type 3B,4,5,6 coverall – Dupont brand

			Percentage calculated from the total quantity of active substance found on each layer						
			Anti-liseron d:1	Anti-liseron d:1/50	Traffic Allées d:1	Traffic Allées d:1/28	Rovral Aqua Flo d:1	Rovral Aqua Flo d:1/667	Sirbel UD d:1/115
Repellent index (%)	Material	Mean	99.5	100.0	99.2	85.4	97.7	82.5	82.0
		Standard Deviation	0.2	0.0	0.4	15.3	0.5	8.5	16.5
Adsorption index (%)		Mean	0.4	0.0	0.7	14.6	2.3	17.5	18.0
		Standard Deviation	0.2	0.0	0.3	15.3	0.5	8.5	16.5
Penetration index (%)		Mean	0.0	0.0	0.1	0.0	0.0	0.0	0.0
		Standard Deviation	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Repellent index (%)	Seams	Mean	97.8	99.7	96.3	72.1	89.0	72.3	92.8
		Standard Deviation	2.5	0.3	2.0	2.2	15.3	19.3	3.0
Adsorption index (%)		Mean	2.2	0.3	3.7	27.4	11.0	27.7	7.2
		Standard Deviation	2.5	0.3	2.0	2.2	15.3	19.3	3.0
Penetration index (%)		Mean	0.1	0.0	0.0	0.5	0.0	0.0	0.0
		Standard Deviation	0.0	0.0	0.0	0.4	0.0	0.0	0.0

Table 11: Reference tested: Polyester/cotton (65/35) water-repellent coverall – Guy Cotten brand – 280 g/m^2

			Percentage calculated from the total quantity of active substance found on each layer											
			Sekoya d:1	Sekoya d:1/500	Reldan 2M d:1	Reldan 2M d:1/375	Traffic Allées d:1			Traffic Allées d:1/28			Anti-liseron / Noverxone d:1	Anti-liseron / Noverxone d:1/50
							Brand new	After 3 washes	After 10 washes	Brand new	After 3 washes	After 10 washes		
Repellent index (%)	Material	Mean	93.4	88.0	60.7	70.1	94.0	45.3	2.3	94.2	0.0	0.0	98.8	99.7
		Standard Deviation	5.3	2.3	20.7	10.2	1.5	10.6	1.6	0.5	0.0	0.0	0.3	0.2
Adsorption index (%)		Mean	6.6	11.5	39.3	29.2	6.0	49.9	72.0	5.8	82.9	37.4	1.2	0.2
		Standard Deviation	5.3	2.5	20.7	9.2	1.5	6.5	4.3	0.5	29.7	3.7	0.3	0.1
Penetration index (%)		Mean	0.0	0.5	0.0	0.7	0.0	4.8	25.7	0.0	17.1	62.6	0.0	0.1
		Standard Deviation	0.0	0.2	0.0	1.1	0.0	5.0	4.8	0.0	29.7	3.7	0.0	0.1

			Percentage calculated from the total quantity of active substance found on each layer							
			Success 4 d:1			Success 4 d:1/5000			Opus d:1	Opus d:1/100
			Brand new	After 3 washes	After 10 washes	Brand new	After 3 washes	After 10 washes		
Repellent index (%)	Material	Mean	90.4	58.1	39.7	85.8	4.7	0.1	99.8	85.9
		Standard Deviation	0.8	10.7	0.7	6.1	7.0	0.1	0.4	2.3
Adsorption index (%)		Mean	9.6	41.9	60.3	12.8	94.3	63.3	0.2	14.1
		Standard Deviation	0.8	10.7	0.7	5.8	6.3	25.3	0.4	2.3
Penetration index (%)		Mean	0.0	0.0	0.0	1.4	0.9	36.6	0.0	0.0
		Standard Deviation	0.0	0.0	0.0	0.9	1.1	25.2	0.0	0.0

Table 12: Reference tested: Polyester/cotton (65/35) water-repellent coverall – Biomidi brand – 300 g/m^2

			Percentage calculated from the total quantity of active substance found on each layer											
			Sekoya d:1	Sekoya d:1/500	Reldan 2M d:1	Reldan 2M d:1/375	Traffic Allées d:1			Traffic Allées d:1/28			Anti-liseron / Noverxone d:1	Anti-liseron / Noverxone d:1/50
							Brand new	After 3 washes	After 10 washes	Brand new	After 3 washes	After 10 washes		
Repellent index (%)	Material	Mean	97.4	87.3	0.0	34.1	85.3	75.0	48.4	90.8	66.6	0.0	99.4	100.0
		Standard Deviation	0.4	0.2	0.0	6.4	2.3	15.3	13.4	4.6	10.7	0.0	0.5	0.0
Adsorption index (%)		Mean	2.6	10.1	100.0	65.7	14.7	25.0	51.6	9.2	33.4	80.0	0.6	0.0
		Standard Deviation	0.4	0.5	0.0	6.3	2.3	15.3	13.4	4.6	10.7	10.0	0.5	0.0
Penetration index (%)		Mean	0.0	2.6	0.0	0.2	0.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0
		Standard Deviation	0.0	0.5	0.0	0.2	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0

			Percentage calculated from the total quantity of active substance found on each layer							
			Success 4 d:1			Success 4 d:1/5000			Opus d:1	Opus d:1/100
			Brand new	After 3 washes	After 10 washes	Brand new	After 3 washes	After 10 washes		
Repellent index (%)	Material	Mean	96.9	86.3	46.3	92.6	76.2	19.1	77.2	80.0
		Standard Deviation	1.8	0.9	11.0	1.7	14.7	31.4	1.1	1.3
Adsorption index (%)		Mean	3.1	13.7	53.7	7.2	23.5	80.5	12.3	19.6
		Standard Deviation	1.8	0.9	11.0	1.6	14.5	31.2	1.8	1.4
Penetration index (%)		Mean	0.0	0.0	0.0	0.1	0.3	0.4	10.6	0.3
		Standard Deviation	0.0	0.0	0.0	0.1	0.2	0.2	2.9	0.1

Table 13: Reference tested: Polyester/cotton (65/35) water-repellent coverall – Heros Blister brand – 230 g/m^2

			Percentage calculated from the total quantity of active substance found on each layer											
			Sekoya d:1	Sekoya d:1/500	Reldan 2M d:1	Reldan 2M d:1/375	Traffic Allées d:1			Traffic Allées d:1/28			Anti-liseron / Noverxone d:1	Anti-liseron / Noverxone d:1/50
							Brand new	After 3 washes	After 10 washes	Brand new	After 3 washes	After 10 washes		
Repellent index (%)	Material	Mean	97.5	45.3	32.0	59.9	69.7	54.1	40.5	37.6	0.0	0.0	63.0	57.2
		Standard Deviation	0.9	10.9	22.9	4.1	4.3	3.3	3.3	17.7	0.0	0.0	10.4	32.3
Adsorption index (%)		Mean	2.5	53.5	68.0	40.0	30.3	45.9	59.5	62.4	84.5	81.0	37.0	42.8
		Standard Deviation	0.9	10.6	22.9	4.2	4.3	3.3	3.3	17.7	21.2	10.2	10.4	32.3
Penetration index (%)		Mean	0.0	1.2	0.0	0.1	0.0	0.0	0.0	0.0	15.5	19.0	0.0	0.0
		Standard Deviation	0.0	0.6	0.0	0.1	0.0	0.0	0.0	0.0	21.2	10.2	0.0	0.0

			Percentage calculated from the total quantity of active substance found on each layer			
			Success 4 d:1	Success 4 d:1/5000	Opus d:1	Opus d:1/100
Repellent index (%)	Material	Mean	86.4	60.6	97.3	17.1
		Standard Deviation	2.7	12.7	0.3	14.9
Adsorption index (%)		Mean	13.6	38.8	2.7	82.7
		Standard Deviation	2.7	12.3	0.3	14.9
Penetration index (%)		Mean	0.0	0.6	0.0	0.2
		Standard Deviation	0.0	0.4	0.0	0.0

Annex 3: Results of the permeation tests

Table 14: Reference tested: Tyvek Classic Cat III, Type 4,5,6 coverall – Dupont brand

Reference		Sampling areas	Sampling time (min)		Anti-liseron d:1		Anti-liserond:1/50		Traffic Allées d:1		Traffic Allées d:1/28		Rovral Aqua Flo d:1		Rovral Aqua Flo d:1/667		Sirbel UD d:1/115	
					µg/cm²	%	µg/cm²	%	µg/cm²	%	µg/cm²	%	µg/cm²	%	µg/cm²	%	µg/cm²	%
Tyvek Classic Plus Cat III, Type 4,5,6 coverall – Dupont brand	MTD_132 (2012) Determination of resistance of materials to permeation by liquids	Material	10	Mean	2,924.3	0.49	0.0	0.00	0.0	0.00	0.0	0.00	2.6	0.00	0.0	0.00	0.0	0.00
				Standard Deviation	4,133.2	0.70	0.0	0.00	0.0	0.00	0.0	0.00	3.3	0.00	0.0	0.00	0.0	0.00
			30	Mean	2,520.5	0.43	1.2	0.01	0.1	0.00	0.0	0.00	17.2	0.00	0.0	0.00	0.0	0.00
				Standard Deviation	3,414.5	0.58	1.7	0.01	0.0	0.00	0.0	0.00	23.4	0.00	0.0	0.00	0.0	0.00
			240	Mean	21,049.1	3.56	1.3	0.01	4.3	0.00	9.8	0.10	29.7	0.00	99.8	2.70	15.0	0.39
				Standard Deviation	22,499.7	3.81	1.8	0.02	3.6	0.00	12.3	0.13	35.0	0.00	71.0	1.92	21.2	0.55
			480	Mean	31,371.2	5.31	4.5	0.04	14.4	0.01	44.6	0.45	30.1	0.00	122.7	3.32	22.6	0.59
				Standard Deviation	23,801.6	4.03	3.3	0.03	12.6	0.00	51.6	0.53	31.4	0.00	86.9	2.35	32.0	0.83
		Seams	10	Mean	7,177.4	1.21	0.0	0.00	0.2	0.00	2.4	0.02	0.8	0.00	0.0	0.00	0.0	0.00
				Standard Deviation	9,619.6	1.63	0.0	0.00	0.1	0.00	1.7	0.02	0.4	0.00	0.0	0.00	0.0	0.00
			30	Mean	8,861.8	1.50	0.0	0.00	0.2	0.00	3.2	0.03	2.0	0.00	79.5	2.15	0.0	0.00
				Standard Deviation	9,732.1	1.65	0.0	0.00	0.1	0.00	2.2	0.02	1.6	0.00	112.5	3.04	0.0	0.00
			240	Mean	31,700.2	5.36	0.0	0.00	1.7	0.00	8.8	0.09	10.0	0.00	369.3	9.99	9.2	0.24
				Standard Deviation	22,052.7	3.73	0.0	0.00	1.7	0.00	6.7	0.07	9.5	0.00	448.4	12.14	13.1	0.34
			480	Mean	32,019.7	5.42	0.1	0.00	3.7	0.00	42.5	0.43	6.1	0.00	652.8	17.67	113.3	2.95
				Standard Deviation	8,741.7	1.48	0.2	0.00	3.9	0.00	44.1	0.45	3.5	0.00	807.6	21.86	150.0	3.91

Table 15: Reference tested: Tychem C Classic Cat III, Type 3B,4,5,6 coverall – Dupont brand

Reference		Sampling areas	Sampling time (min)		Anti-liseron d:1		Anti-liseron d:1/50		Traffic Allées d:1		Traffic Allées d:1/28		Rovral Aqua Flo d:1		Rovral Aqua Flo d:1/667		Sirbel UD d:1/115	
					µg/cm²	%	µg/cm²	%	µg/cm²	%	µg/cm²	%	µg/cm²	%	µg/cm²	%	µg/cm²	%
Tychem C Classic Cat III, Type 3B,4,5,6 coverall – Dupont brand	MTD_132 (2012) Determination of resistance of materials to permeation by liquids	Material	10	Mean	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
				Standard Deviation	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
			30	Mean	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
				Standard Deviation	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
			240	Mean	0	0.00	0	0.00	0	0.00	0	0.00	0.1	0.00	44.2	1.20	0	0.00
				Standard Deviation	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	62.5	1.69	0	0.00
			480	Mean	0	0.00	0	0.00	0	0.00	0	0.00	0.1	0.00	47.0	1.27	0	0.00
				Standard Deviation	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	66.5	1.80	0	0.00
		Seams	10	Mean	0	0.00	0	0.00	0	0.00	1.1	0.01	0	0.00	0	0.00	0	0.00
				Standard Deviation	0	0.00	0	0.00	0	0.00	1.6	0.02	0	0.00	0	0.00	0	0.00
			30	Mean	0	0.00	0	0.00	0	0.00	1.9	0.02	0.1	0.00	0	0.00	0	0.00
				Standard Deviation	0	0.00	0	0.00	0	0.00	2.7	0.03	0	0.00	0	0.00	0	0.00
			240	Mean	0	0.00	0	0.00	0.1	0.00	4.6	0.05	0.1	0.00	67.4	1.83	0	0.00
				Standard Deviation	0	0.00	0	0.00	0	0.00	6.5	0.07	0	0.00	95.4	2.58	0	0.00
			480	Mean	0	0.00	0	0.00	0	0.00	4.0	0.04	0.1	0.00	155.3	4.20	0	0.00
				Standard Deviation	0	0.00	0	0.00	0	0.00	5.7	0.06	0	0.00	31.0	0.84	0	0.00