

Assessment of contaminants in Wildland Personal Protective Clothing (PPC) made from PROBAN® treated cotton

Background:

A group of SA Country Fire Service (CFS) volunteers who are Work Health and Safety (WHS) representatives operating under nationally harmonised WHS legislation prepared a discussion paper in February 2014, that raised concerns about the possible levels of contamination found in wildland personal protective clothing (PPC). The CFS brought the issue to the attention of AFAC Council, as there are potential national implications, particularly if a problem was determined to exist. The AFAC Board subsequently approved funding for independent testing to be undertaken by the CSIRO to ascertain if there is an issue.

The AFAC Manager Standards organised for testing to be undertaken on:

- a new unused reference garment supplied by the RFS, and
- two garments that had been worn in bushfire smoke, supplied by each of the RFS, CFA and CFS.

This totalled seven garments. AFAC received the report from the CSIRO on Friday 13th February and it identified two issues of concern namely the significant levels of dust and respirable particles that are stored in the fabric and unexpectedly, the levels of formaldehyde both in the uniform fabric and what is released into the air following sealed storage of the uniforms. A meeting was subsequently held involving:

- Russell Shephard - AFAC Manager Standards
- Judy Gouldbourn - AFAC Manager Human Resources,
- Samantha Kitchen, AFAC Project Officer and
- The test garment providers represented by:
 - Arthur Tindall - CFS
 - Mark Tarbett – CFA
 - Harry Vertsonis – RFS

The purpose of this Industry Safety Advice is to summarise details of those discussions and provide supporting research to AFAC members.

Attached are the CSIRO 'Report on Identification and Assessment of Contaminants in wildland PPC' and the CSIRO 'Redistribution Report' which is methodology. This second report may be of little benefit but is included for completeness.

AFAC does not formally endorse the CSIRO Report and notes it is 'Commercial in Confidence'. As such, the report is not to be circulated further beyond AFAC Member agencies. Three issues are addressed below with recommendations.

Oversight:

- The test garments used in the testing were all made from PROBAN® treated cotton, the most widely used fabric by AFAC member agencies for firefighting garments, station wear and for SES. It is also widely used in industry.
- The purpose of the testing was not to specifically test PROBAN® treated cotton, as it has been in use in Australia for in excess of thirty years, without apparent health related issues being raised or identified.
- PROBAN® is a chemical treatment manufactured by SOLVAY, (formerly Rhodia), that is applied by SOLVAY licensees to cotton based fabrics. (Similar processes and chemicals are used by other manufacturers e.g. Westex - Indura Ultrasoft.)
- Suppliers have previously provided reassurance that PROBAN® polymer has been included in the Oeko-Tex list of approved chemicals which is “guaranteeing the textile does not contain any harmful substances detrimental to human health”. [http://www.solvay-proban.com/en/binaries/2013-Solvay-Proban%20Flyer%20\(English\).pdf](http://www.solvay-proban.com/en/binaries/2013-Solvay-Proban%20Flyer%20(English).pdf)
- Formaldehyde is used in the polymerization process when treating the fabric so it is therefore expected that formaldehyde would be detected on/in the finished fabric. The success of the chemical application is reliant on strict quality controls being adhered to by the applicators and ongoing quality monitoring and batch testing of the final product.
- The focus of the testing conducted by the CSIRO was to identify what volatile organic compounds and respirable particles existed in the fabric after they had been used combating bushfires.

Formaldehyde and its effects:

- Formaldehyde is naturally present in the air we breathe and in the food and water we eat and drink. In addition, a wide range of human domestic and industrial activities is responsible for both direct and indirect release of formaldehyde into the atmosphere from diffuse and point sources. The principal route of exposure is by inhalation, via indoor and outdoor (ambient) air.
- Formaldehyde does not accumulate in the environment as it is rapidly broken down within a few hours by sunlight, bacteria and water. Humans metabolise formaldehyde quickly and it is not stored in the body.
- Large quantities of formaldehyde are emitted during the combustion of organic materials, i.e. bushfires.
- Formaldehyde is classified by Safe Work Australia as a probable human carcinogen that has been linked to leukaemia, cancers of the nasopharynx and to a lesser extent, cancers of the sinonasal passage.
- The Australian Firefighters’ Health Study, published in December 2014 by Monash University, examined cancer incidence and causes of death among a cohort of 232,871 current and previously serving career and volunteer firefighters and is the largest study ever conducted on firefighter health. The Review of the study findings demonstrate that there are no statistically significant elevated incidence rates of any of cancers linked to formaldehyde* within the cohort when compared to incidence rates seen in the Australian population. Additional research undertaken by Monash University for the Country Fire Authority Victoria on the health of firefighters who had served at the Fiskville training centre also found no increased incidence of any of these cancers among this group.
*nb: cancers of the nasopharyngeal sub category were not looked at separately as they are very rare. These were considered in the overall group of lip, pharynx etc.

Issue 1 – Release of formaldehyde from PROBAN® treated fabric into the atmosphere

- Breathing formaldehyde vapours can result in irritation of the nerves in the eyes and nose, which may cause burning, stinging or itching sensations, a sore throat, teary eyes, blocked sinuses, runny nose and sneezing. These symptoms are often experienced when smoke is encountered and can be caused by a range of substances.

- A test conducted by the CSIRO using an in-house process was designed to simulate the storage of a uniform in an enclosed space. This test indicated that after twenty-four hours of storage in a confined space the levels of formaldehyde emitted were found to be of concern with six of the seven samples, including the control sample, exceeding the allowable time weighted average, (TWA), exposure level of 1ppm with three of those samples also exceeding the allowable short term exposure level, (STEL), of 2ppm.
- The testing undertaken whilst reflecting exposure of PPC being removed from a kit-bag does not reflect exposures likely to be experienced by personnel wearing the garments. Safe Work Australia Guideline limits (TWA & STEL) are based on ambient air concentrations as opposed to the static area sampling used by CSIRO which is not acceptable for determining compliance with exposure standards.

A Bushfire CRC research program identifying air toxins in bushfire smoke took readings of air toxins via a monitor worn on PPC. This testing was undertaken in accordance with Safe Work Australia Guidelines. A review of this research indicates extremely low levels of formaldehyde exposure whilst wearing PROBAN® treated garments.

Recommendations:

- Agencies advise members of the dangers of breathing in fumes that are emitted from PROBAN® treated PPC that has been stored in a confined space, e.g. a kit bag. Wherever possible, PROBAN® treated PPC should be stored in a well-ventilated environment but if this is not possible precautions should be taken to avoid breathing in the fumes (gases) emitted when opening the confined space.
- Wherever PROBAN® treated PPC is stored in a sealed or confined space, ensure that it is opened in a well-ventilated area and allow a short time to pass before removing.

Issue 2 –Formaldehyde in the fabric

- Formaldehyde is a potential skin irritant and skin sensitizer.
- Skin contact with formaldehyde can cause skin rashes and allergic skin reactions. The levels of exposure which may cause these allergic reactions will vary significantly between individuals.
- There is no legal limit on the level of formaldehyde permitted in textiles within Australia but the Australian Competition & Consumer Commission, (ACCC), has adopted an interim reference figure of 100 parts per million, (ppm), for garments contacting the skin and 300ppm for other garments and fabrics.
- A test conducted by the CSIRO using an internationally recognised testing process, (ISO14184-1) was used to determine what formaldehyde existed in the fabric.
- The highest concentration of formaldehyde detected was 300ppm which was found in the control garment. The remaining six garments had readings ranging from 66ppm to 280ppm.
- In most instances the level of concentration of formaldehyde dropped significantly after washing with the control sample dropping from 300ppm to 130ppm. The remaining six garments had readings from 64ppm to 150ppm.

Recommendations:

- Agencies instruct personnel to wash separately PROBAN® treated cotton garments before they are worn for the first time and after each use.
- Agencies advise members that direct skin contact with PROBAN® treated PPC may cause skin irritation. The known incidence of skin irritation time (over 30 years) that PROBAN® treated cotton has been used in Australia is minimal. Where there is evidence that skin irritation is occurring when a PROBAN® treated over-garment is being worn, individuals should wear long sleeve shirts and long pants underneath these garments.

Issue 3 – Accumulation of respirable particles

- Safe Work Australia has issued limits on respirable limits for six specific substances which are quartz, cristobalite, tridymite, fumed silica, coal dust and soapstone. Where no specific standard applies and the substance is inherently low toxicity and free from toxic impurities dust exposure should be maintained below 10mg/m³ over an 8 hour TWA.
- CSIRO used an in house “beating test” described as the equivalent of shaking a garment to determine particulate content. Airborne concentrations were then calculated.
- Two garments, one of which was the control garment did not release any particulates of concern. Only one of the five remaining garments which came in at 11mg/m³ exceeded the 8 hour TWA.

Recommendations:

- Agencies instruct personnel not to shake firefighting garments as a means of removing dust and particulates before washing.
- Agencies instruct personnel to wash separately PROBAN[®] treated cotton garments after each use so as to minimise the amount of dust and particulate matter trapped in uniforms.

Conclusion:

PROBAN[®] treated cotton has been in use by Australian emergency services agencies for in excess of thirty years without any significant issues or concerns being identified. The Australian Firefighters’ Health study provides some reassurance that records indicate the incidence of cancers associated with formaldehyde are not elevated for Australian firefighters.

What the testing conducted by the CSIRO has done is raise concerns about how the PPE is stored and handled. The unexpected issue is the amount of formaldehyde both retained and given-off by the PROBAN[®] treated cotton which is at levels outside the product manufacturers stated release levels. This warrants further investigation. AFAC will pursue this through the engagement of the AFAC PPE Technical Group.

Each agency will need to make its own assessment however the AFAC review team is of the view that making users aware of the need to adopt appropriate handling and laundering procedures will address the issues raised in the CSIRO report.

Attachments:

NA

Responsible Officers:

Drafted by review team chaired by Russell Shephard
AFAC Manager Standards

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Home Agency:

AFAC