

PFAS – Questions and Answers

In April 2017, a survey was sent to all FRNSW personnel inviting questions in relation to historical use of PFAS-containing firefighting foam. These questions have been responded to by Health and Safety, with input and peer-review from Professor Alison Jones (Pro-Vice Chancellor, Health Strategy, University of Wollongong). All respondents provided consent to share publish these questions in a de-identified format.

- 1. During the 1970's and early 1980's another foam/detergent product used by the then NSW Board of Fire Commissioners (prior to its annexation by Premier Griener in 1985) was a product that if memory serves me correctly had a trade or product name Phenol, Fenol or something similar. Making enquiries within NSWFR and its Employees Union have proven fruitless. I would like to know the health implications of this product and what steps NSWFR have undertaken (or will be) to resolve my concerns of said product.**

Phenol is not a type of firefighting foam, and does not contain PFAS. It is a general cleaning product that was previously used by FRNSW, but withdrawn from use in 1988, per in-orders 1988/9.

The [National Industrial Chemicals Notification and Assessment Scheme](#) (NICNAS) advises that repeated exposure to Phenol through via oral, inhalation, and dermal (skin absorption) routes may result in mucosal irritation, diarrhoea, dark urine, weakness, muscle pain, loss of appetite and body weight, and liver toxicity [1]. In 1988, the occupational dermal exposure limit for phenol in Australia was 19 mg/m³ (time weighted average) [2]. Phenol was not approved or recommended by FRNSW for the cleaning of Breathing Apparatus (BA) (Commissioner's Corner 328).

In 1989 the International Agency for Research on Cancer (IARC) evaluated Phenol as 'not classifiable for carcinogenicity to humans (Group 3)' [2]. This classification was reviewed and retained in 1999 and currently remains in place [3].

- 2. For years, members were required to fill portable foam extinguishers with AFFF. No safety guidelines were provided, resulting in hands and forearms being covered in foam residue. What effect will this have on those members future health.**

While PFOS is classified as a persistent organic pollutant [4] the Australian Department of Health [5] and NSW Health [6] advise there is no consistent evidence that PFOS or PFOA cause any specific illnesses in humans, including cancer.

Scientists have found some associations between PFAS exposure (via inhalation or ingestion) and various observations including increased blood pressure, cholesterol and uric acid levels. However other studies have failed to find associations between these variables, which may suggest that these observations may be due to other factors not considered by the researchers [7]. It is important for the scientific community to use these associations to

inform future research, however at this stage there has been no clear causal relationship found between PFAS and any specific health outcome.

The [International Agency for Research on Cancer](#) has determined that PFOA is 'possibly carcinogenic to humans' (group 2B) [8], however this classification is based on limited scientific evidence, mostly from [animal studies which are poorly generalisable to humans](#).

Other examples of type 2B substances include diesel fuel, bitumen and aloe vera. PFOS has not yet been evaluated by the IARC, but a recent study by Arrienta-Cortes [9] suggests PFOS is 'not classifiable as to its carcinogenicity to humans' (IARC category 3), once again demonstrating a lack of causal evidence. The question of whether PFAS exposure is linked to cancer was discussed at the PFAS Health Information Sessions. You can access the video recordings discussing [prostate cancer here](#), or [haematological cancers here](#) (please click to follow links).

- 3. Firefighters were told that foam concentrate was harmless and no protective equipment was required. Firefighters who like myself were stationed at foam stations and who handled large quantities of the foam concentrate without any protective equipment as directed by FRNSW management are they;**
- a. At what greater risk to cancer and other illnesses, than other FRNSW firefighters and people at Williamstown near the RAAF base that may have drunk contaminated ground water from water run-off from the RAAF base?**

As mentioned in the response to question 2 (above), there is presently no consistent evidence that PFOS or PFOA cause any specific illnesses in humans, including cancer [5] [6].

As a precautionary measure, the Australian Government Department of Health (based on data from animal studies) has issued guidance values for acceptable levels of PFAS in drinking water [5]. These are available through the [Department's website](#). Information about the Williamstown site investigation and management program can be found on the [Department of Defence website](#).

The US Agency for Toxic Substances and Disease Registry collates data from international peer-reviewed human health assessments published by reputable scientific agencies [7], and has not found data on cancer or other human health risks from PFAS exposure via the oral or inhalation routes. There is currently no evidence of human deaths as a result of skin (dermal) exposure to PFAS, and no human studies demonstrating systemic or organ-specific effects [7].

- 4. What protective equipment should have FRNSW ensured firefighters wear when handling this foam concentrate?**

On 30th March 2007, FRNSW published Safety Bulletins 2007-03, which provides the following instructions regarding AFFF and ATC Firefighting foams:

- When using any type of B-class firefighting foam in fire situations SCBA and full structural firefighting uniform, including gloves, must be worn at all times.
- When decanting or pouring firefighting foam, or cleaning foam making equipment, a minimum level of PPE including: rubber gloves, P2 dust mask, duty wear/overalls and splash proof goggles must be worn.

These measures are consistent with the SDS published by 3M, which recommended skin protection as precaution to avoid potential irritation, redness, swelling, itching, pain and blurred vision [10].

[Commissioner's Orders 2014/12](#) describes the current FRNSW [Recommended Practice for Firefighting foam and foam making equipment](#). Section 4.2 describes the PPE requirements for handling and using the types of foam in the current FRNSW inventory. First aid procedures, decontamination and other safety-related topics are also discussed.

b. **How readily is the foam concentrates absorbed through the skin?**

A study by Franko et al. [11] found that 24% of a sample of PFOA (0.5mg in 1% acetone) was absorbed across human skin over a 24-hour period, and 45% of the sample was retained in the skin. The absorption rate of PFOS through human skin (dermal exposure) is not currently known.

In a recent study of 149 aviation firefighters in Australia, Rotander et al. [12] found no relationship between self-reported skin exposure to AFFF and blood PFOS levels. The authors found that, on average, people who had worked as aviation firefighters for 11 years or more had higher blood PFOS and PFOA than a comparison of pooled blood serum. However, blood PFOS/PFOA levels were not associated with other biochemical indices including cholesterol (LDL, HDL, triglycerides), body mass index, or uric acid levels [12]. It should also be noted that the aviation firefighters in this study were required to participate in training exercises with 3M AFFF every 90 days. For more information on PFAS exposure routes generally, [click here](#). For information about skin exposure to foam concentrate [click here](#).

As mentioned above (see question 3a), there is currently no evidence of human deaths as a result of skin (dermal) exposure to PFAS, and no human studies that clearly demonstrate systemic or organ-specific effects [16].

5. **Back in 1987, all FRNSW firefighters have been exposed to these foam concentrates at the FRNSW training college recharging foam fire extinguishers was an examinable task to be mark as competent as a recruit firefighter. Again no protective equipment was required by the FRNSW trainers or assessors. Throughout my career and I'm sure the vast majority of other firefighters careers they have repeatedly recharged foam fire extinguishers, until FRNSW contracted it to private enterprise. The question is at what risk are FRNSW firefighters because of the repeated exposure to foam concentrate?**

Firefighters and other workers who encounter PFAS (such as manufacturers of Teflon and other PFAS containing products) may have higher blood PFOS and/or PFOA levels than the general population, as found by Rotander et al. [12]. However, as mentioned previously, there is no consistent evidence that PFOS or PFOA cause any specific illnesses in humans, including cancer [11, 16, 8], even amongst those who have higher blood concentrations.

6. **As a FRNSW firefighter, especially being station at a foam station I've attended a number of large fires which required the application of foam. Generally this foam concentrate was proportioned at 6% to make the foam. Again the only protective equipment use by FRNSW firefighters was the old brass buttoned firefighting tunics, helmet and top boots. There was exposed skin, tunics would become saturated with it, and of course the top boots would allow easy access to your feet because they went outside of the woolen trousers, so foam with a 6% concentration of foam concentrate was in contact with large areas of the skin for prolonged**

period of time, on multiple occasions. The question is at what higher risk are firefighters to absorption through the skin when exposed to foam with a 6% concentration for prolonged periods of time than exposure to either the foam concentrate or the people at Williamstown who may have drunk contaminated ground water from the RAAF base?

3M AFFF 6% concentrate contained 1-5% perfluoroalkyl sulfonate (PFOS) salts [10]. However, as discussed previously (see question 3C), the rate of absorption of PFOS through human skin is not known. As noted above, PFOA may be absorbed through the skin at a rate of 24% over 24 hours [11].

Although the Australian Government Department of Health has issued [guidance values](#) for acceptable levels of PFAS in drinking water, these are precautionary only. Scientists and healthcare professions are unable to interpret blood or tissue PFAS concentrations as 'safe' or 'unsafe', as there are currently no known health effects caused by human exposure to PFAS.

7. Will people who have been exposed be having any blood tests. What are risks for people who have been exposed.

Fire & Rescue NSW is following [advice issue by the Australian Government Department of Health](#), which advises that individual blood testing for PFAS is not currently helpful to manage any current medical problems or to predict future health problems [5]. This is consistent with NSW Health advice that indicates blood testing has no current value in informing clinical management [13].

For further explanation of why blood testing is not indicated for clinical purposes, [please see this video](#) featuring Professor Alison Jones. For information on why blood testing cannot determine past exposure accurately, [please see this video recording](#). For information on how blood testing is used in research, [please see this video](#).

8. Is there an increased cancer risk to those people who were required to regularly handle the AFFF concentrate? Does direct skin contact with the concentrate or inhalation of the concentrate's vapor increase the risk of cancer? I'm referring to the firefighters based at dedicated 'foam stations'. Firefighters at these stations were required to maintain AFFF levels on the truck's foam injection system.

It is noted that stations held differing levels of foam stock, and that some stations held foam trailers (In Orders 2002/13) and emergency foam stores (In orders 1996/29). This may have resulted in some firefighters handling foam more often than others, and a different pattern of PFAS exposure.

The Toxicology Excellence for Risk Assessment (TERA) collates scientific data from a number of countries regarding toxicological exposure risk. At this stage, the TERA does not list any evidence of cancer or other human health risks from PFAS exposure via ingestion or inhalation [7]. As previously mentioned, skin exposure was not found to be associated with blood PFAS levels in firefighters [12].

9. When will Firefighters who were exposed to this through AFFF be tested to determine the levels of PFOS and PFOA in their blood.

See question 6.

10. Compared to people in the affected RAAF zones who may have drunk contaminated ground water or eaten vegetables, fruit, or eggs from the contaminated area, how much greater is the

risk to FRNSW firefighters who have handled the foam concentrate without protective equipment and also used/exposed to foam for prolonged periods at a concentration rate of 6% with only firefighting uniform for protection? Remembering that more often than not the uniform and top boots were generally wet from the foam.

See question 3a.

- 11. In 2004 at Fairfield fire station I was operating a new pumper when the foam line burst under pressure. As a result, I was showered in B class foam (3M AFFF) concentrate, resulting in hospitalisation to flush the foam from eyes. I would like to know what long term health risks I may be exposed to and are there any tests I can take to identify if this exposure has caused any health issues. Thankyou**

As mentioned previously (question 3c), the rate of skin absorption of PFOS is unknown, and at this stage there are no known long-term health effects of PFAS exposure [5, 6]. 3M AFFF contained solutes that were irritants to the skin, eyes, and airways [13]. Specifically, it may cause eye redness, swelling, pain, tearing and blurred or hazy vision; and skin irritation. The first aid measures you have described (flushing with water and seeking medical attention) seem appropriate, but if you have any ongoing symptoms you should seek advice from a medical practitioner.

- 12. Thank you, I attended the first session, in which was discussed by Professor Jones that PFOS and PFOA are a very grey area and human consequences of contamination are different to animals and at this point in time not really known. One of the things she stated was that testing would only provide a number, but that number really does not mean anything due to the current lack of knowledge. She also stated that firefighters are exposed to thousands of chemicals due to their occupation! FRNSW are in a position where they currently have firefighters who have been exposed to foam contamination and firefighters who have not been exposed to foam contamination. I believe it would be responsible for FRNSW to test firefighters who have and have not been exposed to foam contamination to start a data base. In 5 years time test those same firefighters again for the 5 year life for each person (not the chemical's half life) because each person is different. Further testing each 5 years may be required to increase knowledge about these (and maybe other) chemicals firefighters are/have been exposed to. Professor Jones stand of do nothing because the numbers currently don't mean anything is self defeating in trying to obtain information/understanding about the effects of such chemicals to people . My question; "Is FRNSW going to test firefighters who volunteer so that they can hopefully assist people like Professor Jones to have a greater insight into the effects of such chemicals on people?"**

We certainly do need to know more about these substances, so thanks for your suggestion. What you are describing here is a 'cohort study' design, which involves collecting information about participant's exposure, then tracking them over a long period of time to identify any 'statistically significant' increase in particular health outcomes.

There are two key issues that would arise when performing a cohort study amongst FRNSW firefighters. The first is that the foam-related exposure would have occurred quite some time ago, and it is difficult (if not impossible) to reliably quantify exposure retrospectively. A current 'snapshot' of PFAS levels could be achieved by measuring participants' blood PFAS levels, however this would not be used to reliably represent the past peak exposure levels. Ideally, the study would have started before, during, or shortly after the PFAS exposure. A second issue is that a very large number of participants would be needed to achieve findings that are statistically significant changes in the prevalence of certain health outcomes.

For more information on difficulties and limitations with retrospective research studies in this area, [please see this video](#).

13. What has been the health issues that we may have, what is the current issues and the long term effects?

See question 3A.

14. References

- [1] National Industrial Chemicals Notification and Assessment Scheme [NICNAS], "HUMAN HEALTH TIER II ASSESSMENT FOR Phenol CAS Number: 108-95-2," Australian Government, ND. [Online]. Available: https://www.nicnas.gov.au/chemical-information/imap-assessments/imap-assessment-details?assessment_id=168. [Accessed 08 05 2017].
- [2] International Agency for Research on Cancer [IARC], "Some Organic Solvents, Resin Monomers and Related Compounds, Pigments and Occupational Exposures in Paint Manufacture and Painting," *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*, vol. 47, 1989.
- [3] International Agency on Cancer Research, "Re-evaluation of Some Organic Chemicals, Hydrazine and Hydrogen Peroxide," *IARC Monographs*, vol. 71, 1999.
- [4] Stockholm Convention, "Listing of POPs in the Stockholm Convention," Stockholm Convention, 05 8 2009. [Online]. Available: <http://chm.pops.int/TheConvention/ThePOPs/ListingofPOPs/tabid/2509/Default.aspx>. [Accessed 08 05 2017].
- [5] Australian Government Department of Health, "Factsheet - Per- and Poly-Fluoroalkyl Substances (PFAS) - Health Effects and Exposure Pathways," nd. [Online]. Available: [http://www.health.gov.au/internet/main/publishing.nsf/Content/44CB8059934695D6CA25802800245F06/\\$File/Health-effects-exposure-pathways.pdf](http://www.health.gov.au/internet/main/publishing.nsf/Content/44CB8059934695D6CA25802800245F06/$File/Health-effects-exposure-pathways.pdf). [Accessed 05 05 2017].
- [6] NSW Health, "Fact Sheet - PFOS and PFOA," 03 04 2017. [Online]. Available: <http://www.health.nsw.gov.au/environment/factsheets/Pages/pfos.aspx>. [Accessed 05 05 2017].
- [7] US National Library of Medicine, "International Toxicity Estimates for Risk (ITER) Fact Sheet," nd. [Online]. Available: <https://www.nlm.nih.gov/pubs/factsheets/iterfs.html>. [Accessed 05 05 2017].
- [8] International Agency for Research on Cancer [IARC], "Some Chemicals Used as Solvents and in Polymer Manufacture," *IARC Monographs*, vol. 07, p. 110, 2016.
- [9] A.-C. Ricardo, P. Farias, C. Hoyo-Vadillo and M. Kleiche-Dray, "Carcinogenic risk of emerging persistent organic pollutant perfluorooctane sulfonate (PFOS): A proposal of classification," *Regulatory Toxicology and Pharmacology*, vol. 83, pp. 66-80, 2017.
- [10] 3M Corporation, MSDS: FC-600F LIGHT WATER(TM) ATC(TM) AR-AFFF 3% OR 6%, St. Paul: 3M, 1999.
- [11] J. Franko, B. J. Meade and H. F. Frasch, "Dermal penetration potential of perfluorooctanoic acid," *J Toxicol Environ Health*, vol. 75, no. 1, pp. 50-62, 2012.
- [12] A. Rotander, L. L. Toms, L. Aylward and J. Mueller, "Elevated levels of PFOS and PFHxS in firefighters exposed to aqueous film," *Environment International*, vol. 82, pp. 28-34, 2014.
- [13] Agency for Toxic Substances and Disease Registry, "Draft Toxicological Profile for Perfluoroalkyls," US Department of Health & Human Services, Atlanta, 2015.
- [14] Australian Government, Department of Health, "Per- and poly-fluoroalkyl substances (PFAS)," 3 04 2017. [Online]. Available: <http://www.health.gov.au/internet/main/publishing.nsf/Content/ohp-pfas.htm>. [Accessed 02 05 2017].
- [15] Secretariat of the Stockholm Convention Clearing House, "Chemicals listed in Annex B," 2008. [Online]. Available: <http://chm.pops.int/Implementation/Alternatives/AlternativestoPOPs/ChemicalslistedinAnnexB/tabid/5850/Default.aspx>. [Accessed 02 05 2017].
- [16] New South Wales Government, "Work Health and Safety Act," 2011. [Online]. Available: <http://www.legislation.nsw.gov.au/#/view/act/2011/10>. [Accessed 02 05 2017].
- [17] New South Wales Government, "Work Health and Safety Regulation," 2011. [Online]. Available: <http://www.legislation.nsw.gov.au/#/view/regulation/2011/674/historical2013-07-01/full>. [Accessed 02 05 2017].
- [18] International Agency for Research on Cancer, "Some Organic Solvents, Resin Monomers and Related Compounds, Pigments and Occupational Exposures in Paint Manufacture and Painting," *IARC Monographs*, vol. 47, 1989.