UFU Aviation Branch: Contamination Research Report

The contamination of UFU Aviation Branch Members by Airservices approved ARFF training practices.

Contents

Executive Summary:

For over 30 years Airservices Australia have been contaminating their Aviation Rescue and Firefighting (ARFF) staff with Perfluorinated Chemicals (PFC's). The family of PFC's include the following chemicals:

- Perfuorobutane sulfonate PFBS
- Perfuorohexane sulfonate PFHxS
- Perfuorohexanoic acid PFHxA
- Perfuorooctanoic acid PFOA
- Perfuorooctane sulfonate PFOS
- Perfuorononanoic acid PFNA
- Perfuorodecanoic acid PFDA
- 8+2 Fluorotelomer alcohol 8:2 FTOH

Voluntary blood screening of ARFF staff in 2013 showed serum levels of PFOS were approximately six to 10 times higher than those found in the general population in Australia. The serum levels of other PFCs like PFHxS in firefighters were approximately 10 to 15 times higher compared to the general population levels in Australia. This testing was 10-11 years after the use of 3M AFFF product was discontinued and 3 years after the Ansulite AFFF product was discontinued. Given the known half-lives of these chemicals, this is very alarming.

The Fiskville CFA study shows the concern for staff is not just with the PFC contamination but with the use of dirty fuels as a regular part of hot fire training. Airservices ARFF have endorsed the use of dirty fuels to save on training costs since the beginning of the service back in the mid 1950s until the early to mid 1990s. The use of waste oils, fuels, solvents, tyres, pallets, treated wood, cars, trucks were encouraged and staff were sent to aircraft hangars to collect waste fuels for this purpose. Most of the training grounds were not paved at that stage, there was no bunding or even any attempt at collection of the burnt waste.

ARFF staff were required to pour these contaminated fuels onto mineral earth, add petrol as an accelerant and then set it on fire. They then extinguished it using AFFF foams with PFCs and worked for up to an hour fighting the fires and overhauling to ensure full extinction. Contamination from these practices effected fire hoses, firefighting equipment, vehicles, boots, gloves and clothing (PPE). Staff then walked it back into their vehicle cabins, fire stations and lunch rooms. Washing of clothing (PPE) was ad hoc at best and black turnout coats were specifically used so the soot would not show up.

The voluntary blood screening conducted by Airservices in 2013 resulted in the participation of approximately 150 of 850 staff. The results of this health surveillance clearly indicated a biological body burden for levels of PFOS and PFHxS compared to the general Australian and

US populations. Based on these findings the UFU has strongly advocated for additional and periodic health screening of effected firefighters, both current and retired. It is well documented that health surveillance increases the risk of creating anxiety and psychological stress for affected individuals, owing to the results of Airservices screening program UFU Aviation Branch members deserve much more than to be ignored, which is the status quo. Genuine consultation with workers is a requirement of WHS legislation, worker health surveillance is no exception, the resistance that Airservices has applied to these requirements is disturbing. Many contemporary studies indicate that exposure to PFOA and PFOS over certain levels may result in adverse health effects, guidance and advice has been issued accordingly.

Typical instruction from consultants and lawyers engaged to advise organisations responsible for widespread contamination of environment and workforce has historically drawn statements such as, “no human health risk has been proven, statements to the counter are misleading and alarmist”. Over time science has eroded the intent of these statements. Airservices endorsed and encouraged the training practices responsible for the biological body burden of PFOS and PFHxS that has now been identified in its workers. Furthermore, training material issued to firefighting recruits during the late 80s had them believe that firefighting foam is, “non-toxic, bio-degradable and able to breakdown when combined into industrial waste water drainage, it is basically a detergent in action”. Interestingly the training material also noted that “the concentrate will not decompose or change with time, the shelf life of the liquid is practically indefinite”.

Even now in the face of significant valid evidence of the harmful effects of PFCs, Airservices is refusing to take any action, stating that they are following Government policy on the PFC issue. The Commissioner of Queensland Fire and Emergency Services recently announced that a process, “be developed for any current or past member of our workforce who has personal concerns about exposure to AFFF, to have access to blood testing should they wish to. This includes the paid and volunteer workforce”. The UFU Aviation Branch strongly endorses this decision because unless the body burden of perfluorinated chemicals is measured, there will be no impetus to conduct future human health studies nor will the data exist to interpret the range and consequence of prior exposure levels.

This report shows credible evidence of the harmful effects of long term and high percentage exposure to PFCs from the UN, WHO, US EPA, ATSDR and many other respected researchers like the C8 Science Panel.

The current ARFF training practices are also a concern as Airservices has never conducted any testing on the use of Jet A1 fuels for training or monitored the level of exposure to the primary toxic components of those fuels. ARFF staff are being subjected to vapour exposure and dermal contact with Jet A1 daily in setting up and extinguishing these training fires. It is very concerning that they are willing to allow their staff to enter fuel spills of Jet A1 and petrol and are expected to work in burnt and unburnt fuels that have been superheated by

fire, sitting on hot fire training pads and hot steel aircraft mock-ups and they are simply unaware of the extent of the toxicity of the vapours they are exposing their staff to. This is despite the MSDS for Jet A1 stating very clearly not to expose staff to vapours or dermal exposure.

Recommendations:

1. FOI on Airservices research, advice and correspondence between managers, defence and government meetings around PFC contamination and contaminated fire grounds, and a copy of what the Government's policy on PFCs is.
2. Send a copy of this report to Comcare.
3. Send a copy of this report to Minister D Chester
4. Send a copy of this report to the ministers and senators of all parties.
5. Make this report available to all ARFF staff.
6. Contact Shine Lawyers (Oakey Litigators), provide a copy of this report and ask if they would consider litigation against Airservices.
7. Provide a copy of this report to all media outlets.
8. Have all staff that have come into contact with the "3M Lightwater" and "Ansulite AFFF" products raise a CIRRIS report for a retrospective chemical exposure.
9. Follow up and record any management coercion, intimidation, bullying or harassment that occurs based on CIRRIS reporting. All resultant correspondence should be written only. Utilise the WHS and Fair Work Acts to ensure legislated workplace rights. WHS Act 2011 sections 107 & 108. Incidence of management coercion relating to these matters has been widely reported.
10. Consult with Industrial Physician/Hygienist/Toxicologist/Epidemiological specialists over appropriate tests that should be agreed to, based on the contaminants reported in this document.
11. Consult with Airservices over the immediate engagement of the AIHW to conduct cancer incidence and mortality study of Aviation Firefighters past and present using the ACD and NDI databases.
12. Use the advice provided above to enforce through the FWC the ARFF EA sect 7.7 .13: Medical examinations are conducted by Designated Aviation Medical Examiners (DAME) who have been authorised by CASA to conduct medical examinations required by us. To meet these requirements the following will be adopted: (c) During the life of this Agreement we both will examine appropriate medical blood testing for firefighting personnel.

Introduction:

Significant media attention has been directed towards the current situations in the CFA Fiskville fire training area and several Defence Force bases with serious contamination issues also mainly attributed to hot fire training. Oakey and Williamtown air bases are two significant defence sites which have had quite a lot of study and research done over the past three years.

The UFU Aviation branch has repeatedly raised these same issues with Airservices and the potential impact on health that has been proven in the Fiskville case and has led to a ministerial enquiry into the CFA's handling of that situation. Unfortunately, the main drive behind the UFUA's approach has been to concentrate specifically on just the chemicals of concern from the previous AFFF foam agents used.

PFOS and PFOA along with the rest of the family of Perfluorochemicals (PFCs) are known to be either ingredients or degradation products from the foams used daily by ARFF staff in training and operations until quite recently.

Unfortunately, the human health studies into PFCs available are being constantly disputed as not conclusive. Some show increased incidence of disease in the tested populations from high dose or continuous low dose PFC exposure over long periods. But these results are then challenged by other researchers. Some researchers who are actively trying to disprove human health effects state that there is a failure to show the causative links between these chemicals and the increase in cancers found in the affected population. They also regularly claim bias in any research that shows a health detriment. It is likely that the significant litigation aspects are the real motivation behind all of the conflicting evidence.

The very indepth and respected C8 Science Panel research, which was used recently by the US courts to successfully award damages to plaintiffs suffering certain cancers, shows Perfluorochemicals probable involvement/link in the increased incidence of:

1. High Cholesterol
2. Kidney Cancer
3. Testicular Cancer
4. Thyroid Disease
5. Pregnancy-Induced Hypertension/Preeclampsia
6. Ulcerative Colitis

This evidence is strong enough for the US Court system to award damages but it is still disputed by Airservices. However, after careful reading of the Fiskville and Oakey research, it is suggested in this discussion paper that the BCOM take a different, much broader and holistic view of the contamination of its members by historically approved ARFF training practices. This means looking beyond just PFCs to the entire gambit of approved training practices, as was done in the Fiskville enquiry.

The similarities between the approved fire training practices historically in place at Fiskville and those historically in place at every ARFF airport training ground in Australia are uncanny. Airservices is also fully aware of a recently conducted, detailed and comprehensive environmental study led by Dr Craig Barnes into contamination at former ARFF training grounds. This included detailed questionnaires of current and former staff members concerning chemicals used and practices in place. They have however, not fulfilled their duty of care to check and monitor the health of current and past employees that were known to be regularly exposed to these contaminants. Ongoing WHS concerns for members exposed to the toxic legacy created by the use these chemicals still exists today, due to the fact that many of these contaminated training sites are still in use.

This paper will seek to show current evidence based points of fact that the BCOM should use in discussions with Airservices, the Minister and to alert Comcare to these issues.

Freedom of Information on research/reports by Airservices:

The UFU BCOM should make a detailed freedom of information request on the environmental research conducted into contaminated training sites by Airservices. Focussed on the work of Dr Craig Barnes, but more broadly across the Airservices Environmental section. This should include the full range of evidence gathered to inform any reports generated to ensure that vital WHS information on staff contamination is not missed. It also should include any briefing notes/reports to the board, executive or ARFF management (sometimes referred to by the organisation as back pocket briefs). Focus should be applied to advice provided to the ARFF Executive by the ARFF/Airservices WHS advisors Andrew McKay and Scott Wade. Especially any items that were of concern to these investigators or recommendations for follow-up work that were either buried, ignored or dismissed. It should include all the returned questionnaires completed by staff listing the suspect practices in place at the time.

The UFU should seek the minutes of any meetings held between Defence and Airservices on the PFC situation, including any direction from Government or Ministers as to **what policy** Airservices is to adopt for the PFC issue. This will be most helpful to provide to the media as

evidence of a cover up if it exists. Airservices mentions that they are following Government Policy in regards to PFCs in their last newsletter for October 2016. The UFU needs to see what that policy is and make it public knowledge.

The focus of this FOI is to show evidence of the full awareness of the potential health risks posed by the historical training practices and the inaction of Airservices and ARFF management in fulfilling their duty of care under the WHS Act to past and serving ARFF staff, to check for evidence of a cancer cluster within this cohort. Some past ARFF members were contacted for their input into this environmental study. Note that a previous FOI now available online at: http://defence.gov.au/FOI/Docs/Disclosures/387_1415_Document.pdf shows that Defence is being quite selective with the advice they have been given as to the human health effects. This document dated May 2003 clearly identifies a relationship between these chemicals and negative impacts on human health.

> "Defence uses Aqueous Film Forming Foam (AFFF) a product produced by the 3M company. This AFFF product contains non-biodegradable fluorosurfactants (specifically perfluorooctane sulfonate (PFOS) and perfluorooctanic acid (PFOA)) that are **environmentally persistent, bioaccumulative and toxic to animals and humans.** Both PFOS and PFOA have been implicated with **a variety of cancers and toxic health effects in humans** that have had long-term exposure to products containing PFOS/PFOA". Colville and McCarron (2003)

It seems that given the evidence provided by these staff, and the events at Fiskville, the lack of WHS follow-up or monitoring of the potential human health effects from these practices is disturbing and these concerns should be immediately shared with Comcare.

Areas where Airservices appears to have not met the requirements of a PBCU under the WHS Act include:

1. Being fully aware of the serious contamination caused by historical and current training practices, the subsequent exposure of past and serving ARFF members and the choice to restrict mechanisms to enable genuine worker representation and consultation. The due diligence applied thus far may be considered to be less than that required by WHS legislation.
2. Being fully aware of and having access to the Fiskville reports and knowing the similarity in training and chemical/fuels handling practices and circumstances of the fire training conducted there.
3. Melbourne Training College (RFFTC) poured millions of litres of AFFF onto training grounds still in use today, right beside a creek that flows into farmland beyond the airport. (Exactly like Oakey but Airservices has not bothered to tell the farmers)
4. Not conducting research to show if there are or have been any increased incidence of cancer within this current and previous ARFF high risk staff population.

5. Limitations on workers' ability to access blood screening. No regular monitoring for adverse health effects is currently in place for our serving and past members.
6. No health monitoring advice has been given to these members, past and present to assist in self-screening or monitoring for potential cancers from these exposures, no advice given to persons living downs stream from one of the most PFC polluted sites in Australia. (Melbourne RFFTC training grounds)
7. No survey on contamination other than the perfluorochemicals has been shown to the UFU or HSR's for consultation on training sites still in use today?
8. If there has been a report where is the consultation with staff associations and HSR's over the results?
9. ARFF Staff with more than 15 years' service will have had similar exposure as the Fiskville instructors to the same mix of assorted flammable chemicals and waste oils/fuels and solid fuels such as tyres, motor vehicles and treated railway sleepers and pallets collected and burned for fire training purposes with full ARFF knowledge and approval.
10. Has the recycled water system in use at the Learning Academy been tested for Pseudomonas Aeruginosa and E Coli or other contaminants on a regular basis?

Lessons from Fiskville:

The first lesson from the Fiskville study appears to be that the organisation needs to accept accountability for what occurred and act to address the potential negative impact on staff health. The foreword of the (Country Fire Authority Victoria) CFA report states:

> "CFA accepts the facts, conclusions and recommendations established in the report and will work to ensure the recommendations are addressed as a matter of priority.
>
> CFA's response will be monitored and audited externally to ensure that the approach taken is consistent, thorough and transparent.
>
> What took place at Fiskville, and to a lesser extent at our other Regional Training Grounds (RTGs), was not good enough and we regret what happened. While we cannot change what happened in the past, we can clearly demonstrate that we can learn from past mistakes and we are committed to making changes to ensure the ongoing health and safety of our people, along with our care for the environment".

The conclusions of the Professor Joy report state:

> "The historical risks to staff and the environment at Fiskville associated with the use of a range of flammable materials in training will never be fully known".

> Viewed from the perspective of modern day health, safety and environment standards and regulations, Fiskville's acceptance and use of donated fuels posed substantial risks which would be unacceptable today. It can be argued that during the 1970s and much of the 1980s, the general level of industry standards and of regulatory requirements in relation to the management of hazardous materials waste was low. However, by the early 1990s that situation had changed and the CFA's own staff responsible for assisting industry to comply with dangerous goods regulations could readily identify that Fiskville was not compliant with regulatory requirements.

This exact situation existed with ARFF's full knowledge and consent over perhaps a longer period as hot fire training has been a regular part of ARFF training since its inception in the early 1950s. While most of those staff would be dead today, there are still a lot of long-serving ARFF staff from the 1970s era who are still alive. The collection of waste oils, fuels, solvents, tyres, motor vehicles, plastics and rubber insulation as well as wood including treated rail sleepers and pallets, were all an accepted part of ARFF training.

A significant amount of this training didn't even take place on a contained training pad, hydrocarbons and solvents were simply poured directly onto mineral earth. Staff then walked through this toxic mix of unknown chemicals adding foam and dry chemicals to the mix. CABA was just being introduced in the 1970s and staff were not required to wear it in all smoke. Even over-trousers are a relatively recent addition to our PPE, historically firefighters trained in their work uniform trousers and boots. It wasn't uncommon for staff to continue to wear these contaminated items for the rest of the shift, including inside the living areas of the fire station.

The Monash University Report into Fiskville of Nov 2014 states:

> "There were 28 deaths and 69 cancers identified among the men in the cohort. Overall, the incidence of cancer was not raised in the cohort as a whole. When compared to the Victorian population, higher than expected cancer rates were observed for melanoma and cancer of the testis in the High group and for brain cancer in the Medium group.
>
> When compared to the Victorian population and to the Australian-born Victorian population, the overall cancer risk was significantly raised for the High group, it was similar to that of both these reference groups for the Medium group and was significantly reduced for the Low group.
>
> When compared to the Low group, there was a statistically significantly increased cancer risk for the Medium and High groups, but the number of cancers in the Low

group was very small, resulting in a lot of imprecision in the results and this is likely to impact on the robustness of these findings",

It is unknown whether there is increased cancer incidence or mortality within current and retired ARFF staff. There is subjective evidence suggesting that this may be the case. The recently enacted Firefighters Act, as detailed in the Safety Rehabilitation Compensation Act introduces a presumption of liability and qualifying periods for prescribed cancers. Despite the known potential for negative health effects, Airservices has taken little action, even less of their own volition. Unless data is collected and evaluated, health outcomes positive or negative are not able to be interpreted. The intention of health monitoring in any form should be to provide a systematic and measurable process that qualifies an organisation to amend policy and procedure with the express intention of positively influencing WHS outcomes and at the same time remaining cognisant of the effect of those decisions. No one in Airservices has bothered to check despite being aware of the high potential. Unless a follow up study is done to show that contaminated staff are suffering negative health effects nothing can be done to assist them or ensure that other staff are properly warned and educated about their increased risks, so that they can have potentially lifesaving monitoring and screening.

In Australia, there are very accurate databases available to track cause of death and cancer. Such as the National Death Index (NDI) which contains cause of death information from 1/1/1980. The Australian Cancer Database (ACD) which lists all cancers and has been a mandatory registration process since 1/1/1982. The Australian Institute of Health and Welfare (AIHW) administer these databases. Cause of death coding may not be fully entered in the database up to 2016. Monash Defence Report P11-12 April 2015.

To undertake a study into cancer incidence and mortality rates for ARFF firefighters using the ACD and NDI databases, Airservices would need to be able to obtain the full name, sex and date of birth (and preferably also the state/territory and/or postcode) of all staff employed as ARFF firefighters who have worked beyond that date and have since retired and all staff who are currently employed. This information would enable this population to be linked to the ACD and NDI databases to obtain cancer and mortality information for ARFF firefighters if the relevant approvals (including from ethics committees) are obtained. This kind of database survey should provide sufficient information to inform whether a database linkage study to investigate the cancer and mortality outcomes for ARFF firefighters is possible.

UFU membership data may already contain some of this information **but the complexity of analysis would require an expert to conduct a proper analysis**. The AIHW were contacted

on 20/10/2016 and a link to a similar database linkage study that AIHW conducted and published recently was provided. The fourth study of mortality and cancer incidence in aircraft maintenance personnel: a continuing study of F-111 deseal/reseal personnel 2016 investigated and reported on the mortality and cancer incidence for F-111 deseal/reseal personnel. The BCOM should pursue Airservices to conduct a similar analysis as soon as possible.

It is also very important to note that the co-operation of CFA senior management was seriously challenged by the parliamentary inquiry committee. This is noted in the foreword to the special report to Parliament:

> For these reasons, it is disheartening for this Committee to have to table this special report. Decision makers within the CFA have done a disservice to the CFA legacy and CFA firefighters twice over. First the tragedy of Fiskville itself and now the refusal to provide vital information to this inquiry.
>
> Every member of the Committee conducting the inquiry into Fiskville is committed to seeking out the truth. The Government referred this important matter to this Committee because in the words of the Premier of Victoria, the Hon. Daniel Andrews, "We need a full and frank inquiry to answer every question, honour every worker and reassure every family".

Given the distinct similarities between Fiskville, Oakey and the ARFF airport training grounds and Airservices' reluctance to monitor contaminated staff member's health, it would be in the UFU's best interest to ask the minister for a similar inquiry into Airservices' historical practices and current refusal to protect and monitor the health of staff, both past and present. The inquiry should be extended to the people living downstream of the old Melbourne RFFTC training grounds as well.

The Victorian inquiry was prompted by the UFU Victoria Branch and the investigative journalism of the Age newspaper and this is another option for the UFU to take if the Minister is not co-operative. It would be naïve of the UFU to think that Airservices has spent over a year collecting evidence of their serious environmental legacy from past training practices and choice of firefighting agents, and failed to look at the health risks and litigation potential of the contamination caused as a direct result of their actions. Airservices have acknowledged their role via letters to affected airports. This written acknowledgement may be useful for any potential litigation.

Further on the CFA's executive's reluctance to co-operate is the following quote from the VIC Enquiry Special Report:

> "The CFA administration has issued many assurances to the Committee that it wants to cooperate with the Fiskville Inquiry. In spite of this the Committee had to issue summonses in order to access critical information. We are now forced to table this report to Parliament due to documents not being produced under the terms of the summons relating to CFA Board papers".
>
> This special report details the extensive withholding of information that is crucial to the Committee's understanding about what happened at Fiskville from 1970 to the present.

The evidence to the committee from the UFU Victoria Branch included evidence of senior CFA managers now employed by Airservices covering up evidence from reports and not acting immediately to protect their staff. Unfortunately, it may take this kind of joint ministerial power or Senate Estimates direction to make Airservices honour their obligations to staff under the WHS Act.

Lessons from Oakey:

The main lesson to draw from the Oakey report is the strong association between the practices in place on the base and the contamination caused. We have an evidence based association in the form of the QLD University study, in that we conducted regular almost daily foam training, and all of the staff from that era recorded significant PFC readings years after substitution of Ansulite AFFF for Solberg RF6, in addition to ceasing training with foam almost completely. It should also be noted that Darwin and Townsville ARFF still retain and use the Ansulite product. Environmental reporting is in place via CIRRIS if it is used for operational turn outs, produced or spilt accidently.

The AECOM Report 2015 on the design of their Oakey study states:

> "In order for a human receptor to be exposed to a chemical contaminant deriving from a site, a complete exposure pathway must exist. An exposure pathway describes the course a chemical or physical agent takes from the source to the exposed individual and generally includes the following elements (USEPA, 1989):
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> - A source and mechanism of chemical release.
> - A retention or transport medium (or media where chemicals are transferred between media).

- A point of potential human contact with the contaminated media.
- An exposure route (e.g. ingestion, inhalation) at the point of exposure.

Where one or more of the above elements is missing, the exposure pathway is considered to be incomplete and there is therefore no direct risk to the receptor".

While the Oakey report is more concerned with the connecting pathways between the contaminants in the ground water and the receptors, the same principles apply with the firefighter's connective pathways between the sources of PFC contamination and their bodies. This includes all contamination eg: fuels, products of combustion not just PFC's.
In the ARFF case the following activities all provide potential pathways for contamination:

Transport Pathways	Comments	Likelihood Significance
Use of Foam (3M Light Water & Ansulite) for training. PFC's included in the ingredients of 3M foams and the degradation products of Ansulite. Now Discontinued.	Direct contact, fire streams, monitors, overspray, mists, steam & vapours. Soaked PPC, Gloves, Boots, vehicles and equipment. Dermal contact, inhalation and ingestion. Still in Use at 2 ARFF Units.	(Very likely) For all ARFF staff with more than 12 years' service. Staff have been contaminated. Proven by Blood Tests conducted by QLD University showing very high PFC levels.
Wind erosion and atmospheric dispersion of upper layers of surface soils at training grounds and other PFC contaminated sites.	Most the ARFF Airport training ground sites consists of large, open gravel areas surrounding the training pads. There is potential for wind erosion and atmospheric dispersion of soil and dust as well as the creation of mud from the application of water. These training grounds are also regularly used for Dry Chemical applications. Leaving Potassium Bicarbonate and anti-wetting agent dusts all over the training ground.	(Very Likely) Operational training still exists on many sites that are known to be contaminated with high levels of PFC's. Staff training on these can ingest and inhale dusts from the training and vehicle operations as well as dermal contact with dusts, muds and soils on the vehicles and equipment used for training. There are also Hydrocarbon residues that are from training fuel overspray, fuel blown of the pads by monitors, windblown mists from

Transport Pathways	Comments	Likelihood Significance
		pressurised fuel systems in a use. Products of Combustion from smoke, particulates, incomplete combustion of fuels Etc.
Leaching from impacted infrastructure (e.g. concrete training surfaces and training aids) to surface run-off and adsorption to soil.	Airservices have had Tests conducted on ARFF Training sites already, these have proven this pathway still exists. (Launceston & Mackay)	(Very Likely) Another source of constantly topping up the PFC contamination of staff from existing training sites despite the cessation of AFFF use and Foam training.
Bulk AFFF chemical handling and storage areas. PFC leaching from old bunds and pads creating contaminated soils, dusts and mud.	Tests Airservices have been conducted on AFFF storage and refilling sites around existing fire stations already. These have proven this pathway still exists.	(Very Likely) Another source of constantly topping up the PFC contamination of staff from existing contaminated sites despite the cessation of AFFF use.
PPC, Equipment washing and maintenance.	All PPC and firefighting equipment used at the contaminated training sites will have dust, soil and mud residues containing PFC's and training fuels, products of combustion, particulates and residues from incomplete combustion.	(Very Likely) Dermal contact with PPC and equipment during the cleaning, maintenance donning and doffing processes. In most cases no gloves or other protection is worn to prevent dermal contact and hand to oral or eye contact.
Foam (AFFF) testing	Testing of foams from the historical usage of AFFF's was a manual process requiring foam to be produced at 6 % and a foam blanket created. Samples of the produced foam was then tested by walking into	(Very Likely) During the period of use it was common for EVT's to conduct these tests regularly on all vehicles usually with the assistance of Operations staff. Current tests use conductivity

Transport Pathways	Comments	Likelihood Significance
	the foam blanket and collecting samples for refractometer tests. Discontinued. Bulk Foam deliveries of concentrates all tested as well on receipt.	meters but still require EVT's to work at the training grounds and expose them to the dusts and residues there. Bulk Foam deliveries of concentrates all tested as well on receipt. This still occurs.
Vehicle wash down and maintenance.	All Fire Vehicles used at the contaminated training sites will have dust, soil and mud residues containing PFC's and training fuels, products of combustion, particulates and residues from incomplete combustion.	(Very Likely) Dermal contact with fire vehicles during the cleaning and maintenance. In most cases, no gloves or other protection is worn to prevent dermal contact and hand to oral or eye contact. Work uniforms can also be contaminated during the vehicle washing process.
Fire related incident response	Direct contact, fire streams, monitors, overspray, mists, steam & vapours. Soaked PPC, Gloves, Boots, vehicles and equipment. Dermal contact, inhalation and ingestion.	(Very likely) For all ARFF staff with more than 12 years' service. Staff have been contaminated. Proven by Blood Tests conducted by QLD University showing very high PFC levels. As AFFF has been discontinued this pathway is now incomplete for current staff employed after the cessation of Ansulite Foams.
Liquid waste collection, storage and Solid waste disposal and treatment	Storage and disposal of contaminated waste has been extremely ad-hoc across the fire stations. Some allowed the fire water from training to run off to the environment for many years. Some stored it in	(Very Likely) ARFF Firefighters and EVT's regularly involved in removal and handling of waste in previous years. This included entering pits and shovelling out solid waste products, and

Transport Pathways	Comments	Likelihood Significance
	dams or bunds and had it collected. Some processed out the Hydrocarbons and then released it to environment or storm water or to trade waste. Firefighters and EVT's managed this process at all locations until it was taken over by Property section several years ago.	assisting with the pump out of liquid wastes. EVTs also used to service training ground separator systems and training aids.
Fire vehicle maintenance	All Fire Vehicles used at the contaminated training sites will have dust, soil and mud residues containing PFC's and training fuels, products of combustion, particulates and residues from incomplete combustion.	ARFF EVT's (Very Likely) Dermal contact with fire vehicles during the cleaning and maintenance process. In most cases, no gloves or other protection is worn to prevent dermal contact and hand to oral or eye contact. Work uniforms overalls can also be contaminated during the vehicle maintenance process. EVT's climb in under and all around vehicles and come into close physical contact with contaminated vehicles.

ARFF has historically used two fluorosurfactant based AFFF foams; Light WaterTM produced by the 3MTM company and Ansulite® produced by Ansul Incorporated. Light Water, a PFOS-based AFFF formulation produced by ECF, was replaced by Airservices with Ansulite at around the same time (2002) the production of PFOS was voluntarily discontinued by 3M (3M 2000 a,b). Ansulite concentrate is telomere based and supposed to be free of both PFOS and PFOA. However, a chemical characterization requested by Airservices found PFOS and PFOA in Ansulite concentrate stored at Cairns airport, and PFOA in Ansulite concentrate stored at Brisbane Airport (AECOM Australia Pty Ltd, 2010). Consequently, in 2010 (approx.),

> Ansulite was replaced with Solberg, which is a fluorosurfactant-free firefighting foam and training with foam ceased in 2010. Rotander. A, Toms. L, Aylward. L, Kay. M, Mueller. J, (2013)

Airservices informs us that AFFF was in use almost daily from the early 1980s until 2010. However, AFFF was formulated in the 1960s and the Defence force report at: http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Foreign_Affairs_Defence_and_Trade/ADF_facilities/Report%20part%20A/c02 states 3M was in use here in Australia from the 1970s so this timeline provided by Airservices may be inaccurate. For 30 years or perhaps even longer Airservices has exposed both their staff and their training grounds (some still in use today) to PFCs. The Agency for Toxic Substances and Disease Registry (ATSDR) Toxicological Profile for PFCs states:

> "Perfluoroalkyls are very stable compounds and are resistant to being broken down in the environment. Perfluoroalkyls in the air are expected to settle to the ground within days to weeks. Perfluoroalkyls may be carried through soil by groundwater and flooding and become airborne during windy conditions. ATSDR (Draft) Tox Profile 2015".

This is a problem with ARFF legacy training grounds still in use for ARFF training. Over a period of 30 years millions of litres of foam have been produced on these training areas. Even with small concentrations of PFCs in the AFFF concentrate that still amounts to significant exposure. Staff are to this day exposed to PFC dusts every time a rain event floats more of these PFC dusts to the surface.

Table 2.1. Chemical composition of 3M's Light Water (FC-203CF) AFFF

Chemical Name	% of Total Composition
Water	69.0 - 71.0
Diethylene glycol butyl ether (butyl carbitol)	20.0
Amphoteric fluoroalkylamide derivative	1.0 – 5.0
Alkyl sulfate salts	1.0 – 5.0
Perfluoroalkyl sulfonate salts (PFOS)	**0.5 – 1.5**
Triethanolamine	0.5 – 1.5
Tolyltriazole (corrosion inhibitor)	0.05

Source: Moody and Field (2002)

A Finnish study conducted in 2014 into the use of AFFF by firefighters found the following routes of contamination:

> "During the suppression of a liquid fire, firefighters may be exposed to AFFF's through inhalation and dermal exposure routes. Contaminated personal protective equipment and fire suits might also increase the risk of hand to mouth transfer and eventual exposure via the gastrointestinal tract. The washing of this equipment is still a big problem for fire brigades in Finland and the use of contaminated firefighting suits is a very common practice. Thus firefighter's short and also long-term occupational exposure to PFAA compounds appears to be more than evident". Toxicology Letters 231 (2014)

This study confirms that the pathways for contamination during training have been confirmed via scientific study. So while ARFF staff were training with AFFF they were being constantly contaminated.

> "An epidemiological study of retired employees involved in the production of PFCs revealed that the human serum elimination half-lives were 4.37yr for PFOA and 8.67yr for PFOS (Burris et al., 2002). In addition, our recent report clearly demonstrated that the serum concentrations of PFOA and PFOS in human were higher in males than in females (Harada et al., 2004b). These data suggest a large difference in the elimination kinetics among species and sexes".

It is interesting to note that even Airservices own study into ARFF Firefighters and EVTs, conducted in 2013, 11 years after ceasing the use of 3M Lightwater AFFF shows high PFC contamination levels with some staff still heavily contaminated.

> "Blood serum concentrations of PFOS, PFHxS and PFOA are summarized for the different stations in Table B3, Appendix B. Serum concentrations of PFOS ranged between 3 ng/ml and 391 ng/ml serum. The highest average concentrations were found in ARFF staff currently working in Rockhampton, Karratha, Adelaide, Sydney and Coolangatta". Rotander. A, Toms. L, Aylward. L, Kay. M, Mueller. J, (2013)

This was one of the same findings by Dr Lloyd-Smith in June this Year 2016.

> "A 2014 study of 149 Queensland firefighters detected multiple PFCs in their serum. The three most prevalent and detected in all samples were PFOS, perfluorohexanesulfonic acid (PFHxS) and PFOA. Their serum levels of PFOS were approximately six to ten times higher than those found in the general population in

Australia. The median/mean level in firefighters was 66/74 ng/mL compared to 12 ng/mL (mean) and 6.8 (median) ng/mL in the general population in Australia. The serum levels of other PFCs like PFHxS in firefighters were approximately 10 to 15 times higher compared to the general population levels in Australia". Lloyd-Smith. Dr M, Senjen. Dr R, (June 2016)

"Even ten years after the phase out of 3M AFFF Industrial Fire Fighting Foam, PFOS serum levels remained above 100 ng/mL and 200 ng/mL in 27% and 3% of the participating firefighters, respectively". Lloyd-Smith. Dr M, Senjen. Dr R, (June 2016)

"As PFOS and PFOA do not break down, are passed from one generation to the next via breast milk and in utero, and have in some cases demonstrated changes in gene expression at very low levels, it is possible that like lead and mercury, there may be no safe level of exposure to PFOS and /or PFOA". Lloyd-Smith. Dr M, Senjen. Dr R, (June 2016)

One of Dr Lloyd-Smiths conclusions in her report is: Special consideration **must** be given to the health and wellbeing of firefighter's and other affected workers.

Olsen. G W, et al (2007) found in his study of 26 retired chemical workers the same slower than normal rate of elimination.

"It is possible that the rate of elimination may have resulted in more shallow slopes as concentrations declined because of the influence of environmental exposure".

This slowing or reversal of PFC elimination was also noted in an internal memo of the 3M company:

"The test results that were reviewed at our meeting seem to substantiate a trend that has been developing over the past 12-18 months - a tendency for these levels in a number of people to no longer show the previous pattern of decline, in fact, a fair number are now demonstrating an increase in blood fluorine levels".

"It is certainly possible that with steady and concentrated production of these surfactants in Bldg. 15, and despite our controls, exposure opportunities are providing a potential uptake of fluorochemicals that exceeds excretion capabilities of the body. If this is true, additional protective measures will be needed". 3M Internal Memo 1984.

Current state of PFC Human Health Studies:

The C8 Science Panel Findings include a series of probable link studies with a positive finding as noted below:

Probable Link Evaluation of Autoimmune Disease July 30, 2012

Conclusion: On the basis of epidemiological and other data available to the C8 Science Panel, we conclude that there is a probable link between exposure to C8 (also known as PFOA) and ulcerative colitis, and find no probable link between PFOA and any of the other autoimmune diseases (rheumatoid arthritis, lupus, type1 diabetes, Crohn's disease, or multiple sclerosis).

Probable Link Evaluation of Cancer April 15, 2012

Conclusion: On the basis of epidemiologic and other data available to the C8 Science Panel, we conclude that there is a probable link between exposure to C8 (also known as PFOA) and testicular cancer and kidney cancer but not any of the other cancers that were considered.

Probable Link Evaluation for heart disease (including high blood pressure, high cholesterol, coronary artery disease) October 29, 2012

Conclusion: On the basis of epidemiological and other data available to the C8 Science Panel, we conclude that
1) there is not a probable link between exposure to C8 (also known as PFOA) and diagnosed high blood pressure (hypertension)
2) there is a probable link between exposure to C8 (PFOA) and diagnosed high cholesterol (hypercholesterolemia)
3) There is not a probable link between exposure to C8 (PFOA) and coronary artery disease, including its manifestations as myocardial infarction, angina and coronary bypass surgery.

Probable Link Evaluation of Pregnancy Induced Hypertension and Preeclampsia December 5, 2011

Conclusion: On the basis of epidemiologic and other scientific data available to the C8 Science Panel, we conclude that there is a probable link between exposure to PFOA (C8) and pregnancy-induced hypertension.

Probable Link Evaluation of Thyroid disease July 30, 2012

Conclusion: On the basis of epidemiological and other data available to the C8 Science Panel, we conclude that there is a probable link between exposure to C8 (also known as PFOA) and thyroid disease.

The C8 studies have been used by US law courts to rule on exposure and contamination cases involving PFCs.

United States Environment Protection Authority (EPA):

The US EPA has also issued drinking water guidelines that confirm the carcinogenic potential of PFOA.

Under EPA's Guidelines for Carcinogen Risk Assessment (USEPA 2005), there is Suggestive Evidence of Carcinogenic Potential for PFOA. Epidemiology studies demonstrate an association of serum PFOA with kidney and testicular tumours among highly exposed members of the general population.

Two chronic bioassays of PFOA support a positive finding for the ability of PFOA to be tumorigenic in one or more organs of rats, including the liver, testes and pancreas. EPA estimated a cancer slope factor of 0.07 per milligram per kilogram-day (mg/kg-day)-1 based on testicular tumours, and confirmed that the lifetime HA based on non-cancer effects is protective of the cancer endpoint.

Extensive data on humans and animals indicate ready absorption of PFOA and distribution of the chemical throughout the body by noncovalent binding to plasma proteins. Studies of post mortem human tissues identify its presence in liver, lung, kidney and bone. PFOA is not readily eliminated from the human body as evidenced by the half-life of 2.3 years among members of the general population.

How the Health Advisories were developed: EPA's health advisories are based on the best available peer-reviewed studies of the effects of PFOA and PFOS on laboratory animals (rats and mice) and were also informed by epidemiological studies of human populations that have been exposed to PFASs. These studies indicate that exposure to PFOA and PFOS over certain levels may result in adverse health effects, including developmental effects to foetuses during pregnancy or to breastfed infants (e.g., low birth weight, accelerated puberty, skeletal variations), cancer (e.g., testicular,

kidney), liver effects (e.g., tissue damage), immune effects (e.g., antibody production and immunity), thyroid effects and other effects (e.g., cholesterol changes). EPA Fact Sheet May 2016.

US EPA: Taken together, the weight of evidence for human studies supports the conclusion that **PFOS exposure is a human health hazard**. At this time, EPA concludes that the human studies are adequate for use qualitatively in the identification hazard and are supportive of the findings in laboratory animals

PFOS Toxicity and Carcinogenicity

In a mortality study of 3M workers at the 3M Decatur, Alabama plant, which spanned a 30 year period, there was a statistically significant association between PFOS levels in workers blood and bladder cancer. Statistical analysis of the mortality data indicated that workers' who were employed in high exposure jobs were 13 times more likely to die of bladder cancer than the general population of Alabama. The study concluded that bladder cancer is a potentially significant yet uncertain endpoint in the analysis of risks from PFOS-related substances (Alexander et al, University of Minnesota, 2001).

To evaluate morbidity outcomes an "episode of care" analysis was completed for 3M employees who had worked at the 3M Decatur, Alabama plant during 1993 and 1998. Increased incidences of cancer and non-malignant growths were not found to be of significance and no mortality risks were reported for most of the cancer types. However, the analysis found an increased risk of episodes of neoplasms of the male reproductive system, as well as an increase in the overall category of cancers and benign growths, and neoplasms of the gastrointestinal tract. Risk ratios were highest in employees with the highest and longest exposures to fluoro chemicals (Olsen et al., 2001).

PFOA Toxicity and Carcinogenicity

The EPA Office of Pollution Prevention and Toxics has been investigating the toxicity of PFOA. PFOA is used extensively in coated (Teflon) cookware and other similar products. Most of the toxicity studies have been conducted with the ammonium salt of PFOA. Epidemiological studies on the effects of PFOA in humans have been conducted on workers. A retrospective mortality study demonstrated a statistically significant association between prostate cancer mortality and employment duration in a PFOA manufacturing plant.

However, an update to this study did not find a significant association. A study which examined hormone levels in workers reported an increase in estradiol levels in workers with the highest PFOA serum levels. Cholesterol and triglyceride levels were positively associated with PFOA exposures. A statistically significant positive association was reported for PFOA and T3 (thyroid hormone) levels in workers but not for any other thyroid hormones (EPA, OPPT Draft Risk Assessment of PFOA, 2005).

Studies have shown that PFOA readily crosses the placenta and is present in the breast milk of rats. Distribution studies have shown that PFOA is distributed primarily to the serum, liver and kidney (EPA, OPPT Draft Risk Assessment of PFOA, 2005).

Based on no adequate human studies and uncertain relevance of the tumours from the rat studies, the EPA in its January 2005 summary, stated that PFOA may be best described as "suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential". (EPA, OPPT Draft Risk Assessment of PFOA, 2005).

In February 2006, however, the EPA Science Advisory Board recommended to EPA that PFOA is a "likely carcinogen" based on its assessment of available studies

UN Persistent Organic Pollutants Review Committee:

United Nations Environment Programme (UNEP) Persistent Organic Pollutants Review Committee (POPRC) Have conducted in depth studies and risk assessments on PFCs and agree with danger and risk of PFOA and PFOS chronic exposure such as our members have been exposed to by Airservices approved chemicals and training practices.

The hazard assessment of PFOS, prepared by the OECD in 2002, concluded that the presence and the persistence of PFOS in the environment, as well as its toxicity and bioaccumulation potential, indicate a cause of concern for the environment and human health.

It is concluded that PFOS is likely, as a result of its long-range environmental transport, to lead to significant adverse human health and environmental effects, such that global action is warranted.

The UK and Sweden have proposed the following classification for PFOS in EU (2005):

- T Toxic
- R40 Carcinogen category 3; limited evidence of carcinogenic effect

- R48/25 Toxic; danger of serious damage to health by prolonged exposure if swallowed
- R61 May cause harm to the unborn child R51/53 Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment has.

UNEP POP (e) Adverse effects: PFOA

(i) There is epidemiological evidence for kidney and testicular cancer, disruption of thyroid function and endocrine disruption in women (Steenland et al., 2012; Knox et al., 2011a, b; Melzer et al., 2010; ECHA 2014);

(ii) There exists experimental evidence from animal studies (Sibinski et al., 1987 and Biegel et al, 2001, cited in ECHA, 2011) that PFOA induces tumours (e.g., in the liver).

Developmental effects have been observed in mice (e.g. Lau et al., 2006). Postnatal administration of ammonium salts of PFOA (APFO) in mice indicated adverse effects on mammary gland development (delayed/stunted) in offspring.

Repeated oral exposure of several species to PFOA showed adverse effects such as mortality, reduced body weight gain, cyanosis and liver cell degeneration and necrosis (ECHA, 2011).

Mothers excrete PFOA via breast milk, which causes concern for the health of breastfed infants (ECHA, 2011).

There is sufficient evidence that PFOA meets the criterion on adverse effects.

So the UN's expert committee on Persistent Organic Pollutants also agrees that there is sufficient evidence to support **significant adverse effects** on human health.

National Industrial Chemicals Notification and Assessment Scheme (NICNAS)

The National Industrial Chemicals Notification and Assessment Scheme has a Human Health Tier 2 assessment on its website for PFOA and PFOS. It is very non-committal in its description of PFC's. It does however discredit its own assessment somewhat in the end by recommending that criteria and classifications for labelling include the Health Warnings below.

PFOA Work Health and Safety

The chemicals are recommended for classification and labelling under the current approved criteria and adopted GHS (Global Harmonized Standard) as below. This assessment does not consider classification of physical and environmental hazards.

PFOA Hazard	Approved Criteria (HSIS)[a]	GHS Classification
Acute Toxicity	Harmful if swallowed (Xn; R22) Harmful by inhalation (Xn; R20)	Toxic if swallowed - Cat. 3 (H301) Toxic if inhaled - Cat. 3 (H331)
Irritation / Corrosivity	Irritating to eyes (Xi; R36)	Causes serious eye irritation - Cat. 2A (H319)
Repeat Dose Toxicity	Toxic: danger of serious damage to health by prolonged exposure through inhalation (T; R48/23) Toxic: Danger of serious damage to health by prolonged exposure if swallowed (T; R48/25)	Causes damage to organs through prolonged or repeated exposure through inhalation - Cat. 1 (H372) Causes damage to organs through prolonged or repeated exposure if swallowed - Cat. 1 (H372)
Carcinogenicity	Carc. Cat 3 - Limited evidence of a carcinogenic effect (Xn; R40)	Suspected of causing cancer - Cat. 2 (H351)
Reproductive and Developmental Toxicity	Repro. Cat 2 - May cause harm to the unborn child (T; R61)	May damage fertility or the unborn child - Cat. 1B (H360D)

Work Health and Safety

The need for regulatory control for workers' health will be determined as part of the regulatory measures for chemicals declared as Persistent Organic Pollutants (POPs). These may include restrictions on the manufacture, import and use of PFOS and the related compounds.

The chemicals are recommended for classification and labelling under the current approved criteria and adopted GHS as below. This assessment does not consider classification of physical and environmental hazards.

PFOS Hazard	Approved Criteria (HSIS)[a]	GHS Classification
Acute Toxicity	Harmful if swallowed (Xn; R22)* Harmful by inhalation (Xn; R20)*	Toxic if swallowed - Cat. 3 (H301) Harmful if inhaled - Cat. 4 (H332)

PFOS Hazard	Approved Criteria (HSIS)[a]	GHS Classification
Repeat Dose Toxicity	Toxic: Danger of serious damage to health by prolonged exposure if swallowed (T; R48/25)*	Causes damage to organs through prolonged or repeated exposure - Cat. 1 (H372)
Carcinogenicity	Carc. Cat 3 - Limited evidence of a carcinogenic effect (Xn; R40)*	Suspected of causing cancer - Cat. 2 (H351)
Reproductive and Developmental Toxicity	May cause harm to breastfed babies (Xn; R64)* Repro. Cat 2 - May cause harm to the unborn child (T; R61)*	May cause harm to breast-fed children (H362) May damage the unborn child - Cat. 1B (H360D)

NICNAS Advice for industry

Control measures

Control measures to minimise the risk from oral exposure to the chemicals should be implemented in accordance with the hierarchy of controls…. Examples of control measures which could minimise the risk include, but are not limited to:

- health monitoring for any worker who is at risk of exposure to the chemical[s], if valid techniques are available to monitor the effect on the worker's health;

It should also be noted that **Australia adopts the GHS coding as of the 01/01/2017** and so the Criteria of Toxicity and Carcinogens as shown in the above tables will be accepted Australian coding in all States and Territories as of then.

Agency for Toxic Substances and Disease Registry:

The Agency for Toxic Substances and Disease Registry (ATSDR), based in Atlanta, Georgia, is a federal public health agency of the U.S. Department of Health and Human Services. They have found the following:

> "Epidemiology studies have found statistically significant associations between serum Perfluoroalkyls levels (particularly PFOA and PFOS) and a wide range of health effects. When the subjects were categorized by serum Perfluoroalkyls levels, dose-response relationships were found for most of the effects. However, findings were not always consistent across studies. However, consistent findings were found for association of serum PFOA and PFOS with increases in serum lipid levels, decreases

in birth weight, increases in uric acid levels, and alterations in biomarkers of liver damage. There was also equivocal evidence of carcinogenicity".

"A number of studies have examined the carcinogenicity of PFOA and PFOS in humans. Occupational exposure studies have found significant increase in deaths from several cancer types, including prostate cancer at one facility and kidney cancer at a second facility. An increase in the risk of kidney cancer was also found in residents living near the second facility. An increased risk of testicular cancer was also found in the highly exposed residents living near the second facility. Other occupational exposure studies have not found significant increases in cancer risk". ATSDR (Draft) Tox Profile 2015

World Health Organisation International Agency for Research on Cancer:

The World Health Organisation (WHO), International Agency for Research on Cancer (IARC) Monographs 110 provide the following assessment:

The evidence for cancer of the testis was considered credible and unlikely to be explained by bias and confounding, however, the estimate was based on small numbers.

The evidence for cancer of the kidney was considered credible; however, chance, bias, and confounding could not be ruled out with reasonable confidence.

The evidence regarding other cancer sites, including the urinary bladder, thyroid, prostate, liver, and pancreas was also evaluated. Some positive associations were observed for cancers of the bladder, thyroid, and prostate, but the results were inconsistent among studies and based on small numbers. The evidence for carcinogenicity for all of these sites was judged to be inadequate.

Overall evaluation: Perfluorooctanoic acid (PFOA) is possibly carcinogenic to humans (Group 2B).

Reproductive Toxicity:
The Navigation Guide Human Studies PFOA

The Navigation Guide Human Studies PFOA. Johnson et al (2014)

Results: We identified 18 human studies that met our inclusion criteria, and 9 of these were combined through meta-analysis. Through meta-analysis, we estimated that a 1-ng/mL increase in serum or plasma PFOA was associated with a –18.9 g (95% CI: –29.8, –7.9) difference in birth weight. We concluded that the risk of bias across studies was low, and we assigned a "moderate" quality rating to the overall body of human evidence.

Conclusion: On the basis of this first application of the Navigation Guide systematic review methodology, we concluded that there is "sufficient" human evidence that developmental exposure to PFOA reduces foetal growth.

The Navigation Guide Non-Human Studies PFOA.

Koustas et al (2014) found:

Results: Twenty-one studies met the inclusion criteria. From the meta-analysis of eight mouse gavage data sets, we estimated that exposure of pregnant mice to increasing concentrations of PFOA was associated with a change in mean pup birth weight of –0.023 g (95% CI: –0.029, –0.016) per 1-unit increase in dose (milligrams per kilogram body weight per day). The evidence, consisting of 15 mammalian and 6 non-mammalian studies, was rated as "moderate" and "low" quality, respectively.

Conclusion: Based on this first application of the Navigation Guide methodology, we found sufficient evidence that foetal developmental exposure to PFOA reduces foetal growth in animals.

The Navigation Guide Integrated Animal and Human Studies PFOA.

Lam et al (2014) found:

Results: We identified 18 epidemiology studies and 21 animal toxicology studies relevant to our study question. We rated both the human and nonhuman mammalian evidence as "moderate" quality and "sufficient" strength. Integration of these evidence ratings

produced a final strength of evidence rating in which review authors **concluded that PFOA is "known to be toxic" to human reproduction and development** based on sufficient evidence of decreased foetal growth in both human and nonhuman mammalian species.

Conclusion: We concluded that developmental exposure to PFOA adversely affects human health based on sufficient evidence of decreased foetal growth in both human and nonhuman mammalian species. The results of this case study demonstrate the application of a systematic and transparent methodology, via the Navigation Guide, for reaching strength of evidence conclusions in environmental health.

Environmental Health Perspectives vol 122 no 2 Feb 2014:

Environmental Health Perspectives volume 122 number 2 of February 2014 provides the following evidence.

> **Results:** After adjusting for age at survey, race/ethnicity, education, ever smoking, and parity, women with higher levels of PFCs had earlier menopause than did women with the lowest PFC levels. We observed a monotonic association with PFHxS: The HR was 1.42 (95% CI: 1.08, 1.87) for serum concentrations in tertile 2 versus tertile 1, and 1.70 (95% CI: 1.36, 2.12) for tertile 3 versus tertile 1. We also found evidence of reverse causation: PFCs were positively associated with rate of hysterectomy, and time since natural menopause was positively associated with serum PFC's.
>
> **Conclusions:** Our findings suggest a positive association between PFC's and menopause; however, at least part of the association may be due to reverse causation. Regardless of underlying cause, women appear to have higher PFC concentrations after menopause
>
> Early menopause is associated with a number of adverse health impacts. For example, results from a meta-analysis demonstrated that menopause before 50 years of age was associated with a 25% increased risk of cardiovascular disease (Atsma et al. 2006) and menopause before age 46 has been associated with increased risk of coronary heart disease and stroke (Lisabeth et al. 2009; Wellons et al. 2012). If PFC levels are predictors of earlier menopause, exposure may also be responsible for increased risk of other serious health outcomes (e.g., cardio vascular disease and stroke). EHP Taylor Et Al (2014)

Melbourne Tullamarine RFFTC (Rescue Firefighting Training College)

The United Firefighters Union is aware that its members have trained at Melbourne RFFTC since it opened in 1973. Every officer, recruit and serving firefighter completed their hot fire training at the RFFTC. This facility was open and operating continuously from 1973 until around 1999. Beyond that it is still in constant use as the training ground for both Tullamarine and Avalon ARFF units.

Over this period the RFFTC would have been in constant use with 3M AFFF and the Ansulite AFFF products. This training ground has a creek running through it and is likely to have seen millions of litres of produced foam poured directly onto the ground for most of its operational service. Even today the training pad is not bunded and significant amounts of Jet A1 is blown off the training capture pad and onto the ground around it.

During its full-time operation as a training college there were several training sites which included a hill where a fuel tanker mock-up was parked and the entire side of the hill would be set alight and extinguished by foam. There were other training areas, one hill where a smaller aircraft mock-up was located and similar fuel spill fires were ignited all around it pouring down the slope on fire and extinguished using foam. There was a shed full of old cars and LPG cylinders and an underground bunker system. Both training aids would be set alight using liquid fuels, gas and fuels like plastics, tyres, cars and wood. These training aids were used for hot fire training exercises daily.

Airservices is aware of the amount of contamination by both foam products with PFCs and a variety of clean and contaminated fuel sources. As far as the UFU is aware, they have made no effort to alert persons living and farming downstream despite knowledge of the issues at Oakey. The Melbourne RFFTC since 1973 would have trained thousands of firefighters during the 3M and Ansulite years.

Summary:

There is a significant weight of hard scientific evidence that shows that PFCs are harmful to human health. There is no doubt at all that Airservices has exposed its work force to a significant amount of PFCs. Testing of staff and training sites has proven this beyond doubt. Airservices has admitted in writing, responsibility for contaminating airport land and environs. It is also likely still contaminating current staff through the continued use of PFC contaminated legacy training grounds, training aids and bulk storage areas where the PFC dusts still rise to the surface in every heavy rain event. Given the widely publicised actions

taken over the CFA training grounds there is no reasonable excuse for an employer with a duty of care to have not taken action to screen the health of past and present staff.

What would a reasonable person do in this case when they see the actions being taken by the government against the CFA and they are fully aware of the similarities between the two services legacy training practices? A definition of a "reasonable person" in law is:

Reasonable Person: A phrase frequently used in tort and Criminal Law to denote a hypothetical person in society who exercises average care, skill and judgment in conduct and who serves as a comparative standard for determining liability.

The decision whether an accused is guilty of a given offence might involve the application of an objective test in which the conduct of the accused is compared to that of a reasonable person under similar circumstances. In most cases, persons with greater than average skills, or **with special duties to society**, are held to a higher standard of care. For example, a physician who aids a person in distress is held to a higher standard of care than is an ordinary person. The Free Dictionary (Legal) 2016

Airservices' reliance on old science and adamant refusal to ensure the health of the staff members they have admitted to contaminating will be held to this same standard and higher as they have a duty of care to their staff and employ experts in both environment and WHS to advise them.

Current Training Practices of Real Concern:

The vast majority of ARFFS training aids are designed around the use of Jet A1 or Kerosene as the training fuel. Smaller amounts of unleaded fuel in the form of Petrol is also used to initiate or start these training fires. While this has been a standard practice by ARFFS for as many years as anyone can remember, what if any research has been done around the safety of these practices. A very simple browse of the Material Safety Data Sheet (MSDS) for Jet A1 provides the following advice:

> In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Clean shoes thoroughly before reuse. Drench contaminated clothing with water before removing. This is necessary to avoid the risk of sparks from static electricity that could ignite contaminated

> clothing. Contaminated clothing is a fire hazard. Contaminated leather, particularly footwear, must be discarded. Get medical attention.

ARFF staff spray Jet A1 or kerosene using a pressurised hose and nozzle as well as through finely atomised sprayers in engine and wheel fire training fire simulators. In doing so they create and are contaminated by fine mists, aerosols, and as the fuel strikes warm/hot surfaces like concrete pads or metal aircraft fire simulator surfaces fuel vapours are generated and available to also permeate clothing, footwear, gloves and for the firefighters to breathe. Most of our staff have operational PPE meant to protect them from fire that is now seriously contaminated by accelerants while training on operational duty.

> The MSDS goes further: Entry into a confined space or poorly ventilated area contaminated with vapour, mist or fume is extremely hazardous without the correct respiratory protective equipment and a safe system of work. Wear self-contained breathing apparatus. Wear a suitable chemical protective suit. Chemical resistant boots

In setting up hot fire training, the fuel spill fires are usually set up in conjunction with internal fires within the Fire Training simulator also known as the large mock up (LMU). This means up to several hundred litres of fuel is sprayed all over the concrete pad and into trays. The fire bins inside the mock up are loaded with wood and or straw and up to a litre of fuel is poured over the wood in each bin to assist ignition. While most internal fires are ignited while wearing breathing apparatus this is not the case during set up of the fire bins. No respiratory protection is worn while setting up and spraying fuel around outside either. A simple walk into any PPE room in Australia will give you a concept of just how contaminated our staff PPE is with fuel residue.

When multiple burns are conducted during the day which is the case quite regularly when conducting officer training, the LMU is not only full of fuel vapour and residue it is also contaminated with products of incomplete combustion from the training fires and trainee's firefighting intervention. Restocking of fire bins or use of unburnt bins is customarily set up with no respiratory protection.

Staff who are now contaminated by hydrocarbon based fuels may also be called on at any time to respond to an operational fire, because the overwhelming majority of ARFF training takes place while staff are on duty. The effectiveness and performance, and therefore the level of protection afforded by the fire ensemble, is known to be reduced when absorption of hydrocarbons/accelerant has occurred.

> MSDS States: May be harmful by inhalation if exposure to vapour, mists or fumes resulting from thermal decomposition products occurs. Vapour, mist or fume may irritate the nose, mouth and respiratory tract.

ARFF light large external fires on the training paid then walk through and stand in the residue with no respiratory protection. Run hose, erect ladders operate equipment for 15-20 mins while the internal firefighting is being supported. With no foam blanket to emulsify and cover the residual training fuels, staff are in direct contact with unburnt fuel and the residues from incomplete combustion and the vapour that they give off after being superheated in a large fire and a now extremely hot LMU and concrete training pad.

Naphthalene

JP-8 is the military equivalent of Jet A-1 with the addition of corrosion inhibitor and anti-icing additives; it meets the requirements of the U.S. Military Specification MIL-DTL-83133E. JP-8 also meets the requirements of the British Specification DEF STAN 91-87 AVTUR/FSII (formerly DERD 2453). NATO Code F-34.

> Another concern involving jet fuels is naphthalene. It is a natural constituent of petroleum-based fuels such as JP-8 with concentrations in the 0.1–0.2% range. The toxicity of high naphthalene exposures results in respiratory, CNS, kidney and liver effects, anaemia and even coma.
>
> EPA has targeted naphthalene due to positive carcinogenic results in rodent inhalation bioassays. As a result the classification for naphthalene could change to"…reasonably anticipated to be a human carcinogen…". ..(aviation) fuels would then be branded as carcinogens. According to 29CFR1910.1000, if a component in the mixture is ≥ 0.1%, the mixture is considered a carcinogen
>
> JP-8 exposure has been shown to increase hearing damage from noise. JP-8 alone did not affect hearing but JP-8 followed by noise resulted in small but consistent disruption of outer hair cell function and hair cell loss greater than for noise alone. The effect was only partially reversible with time (4 weeks) Fechter et al., (2007).
>
> These results are corroborated by an occupational study among jet fuel and noise exposed military workers. JP-8 estimated exposures below 350 mg/m3 (the permissible exposure limit (PEL) at the time the study was performed) for 3 or 12 years, combined with noisy working environments, were associated with increased odds of hearing loss. Fechter et al., (2007).

Research conducted on behalf of the RAAF on aviation fuel JP-8 and the reseal/deseal compounds found that the kerosene component common across Jet A1 and Military fuels was the most toxic component in the tests conducted:

> The following individual components were found to have the highest cellular toxicity:-
>
> 1. Kerosene
> 2. Benzene and butylbenzene
> 3. All Alkanes including iso-octane, decane, dodecane, tetradecane and hexadecane
> 4. Diegme
> 5. N, N Dimethyl acetimide
> 6. Naptha
> 7. Thiophenol
>
> The solvents used in the Deseal/Reseal programme demonstrated either low cell toxicity or manifest toxicity to a lesser extent than the JP8 fuel components
>
> Health studies of exposed workers and other research reports show premature death for some individuals, an increased risk of unusual malignancies in internal organs such as small bowel, erectile dysfunction, and behavioural disturbances. These findings may manifest years after exposure suggesting changes to the cells and tissues not directly exposed to the fuel and solvents. Bowling F.G. (2014)
>
> The cellular findings, supported by other recently published genomic studies, indicate a definite toxicity from JP-8 to exposed cells. The components of JP8 tested **are commonly found in most (aviation) fuels**. The results indicate that there is a need for concern about exposure to fuels in general. Bowling F.G. (2014)

Professor Bowling gave the following Recommendations:

> "The cell results show a definite cellular toxicity from JP8 fuel. The components of the fuel exhibiting toxicity are common to most fuels. Consideration should be given to further studies of workers exposed to fuel of any type".

Benzene

A 2003 US Airforce Study on JP8 Jet Fuel stated:

> "We conclude that despite the low concentration of benzene in fuel, benzene exposure was significant among subjects having regular contact with JP-8. Indeed, 5% and 15% of benzene air measurements were above the 2002 TLV among workers in the moderate and high exposure categories, respectively". Egeghy. P, Hauf-Cabalo. L, Gibson. R, Rappaport. M, (2003)

Benzene is a highly flammable liquid, which occurs naturally in crude oil, natural gas and some ground waters. It is also present in crude oil vapours.

In the UK and Australia, petrol must contain below 1% benzene as determined by ASTM 5580. (In the USA it is between .62% and 1.3% per volume) Small amounts of benzene are produced when some organic substances burn incompletely, e.g. it is found in cigarette smoke and vehicle exhausts. Benzene evaporates easily, and most people can just detect its distinctive smell at concentrations between 2.5 and 5 parts per million (ppm) in air.

ARFF Staff that pour petrol over the Jet A1 or Kerosene training fuels to aid in lighting are regularly exposed to both vapour and splashes of petroleum fuels containing Benzene.

Benzene can be absorbed into your body if you: breathe in air containing benzene vapour; absorb it through your skin; swallow material containing it.

The effects on your health depend on how much benzene you are exposed to and for how long. As with other organic solvents, immediate effects of a single exposure to a high concentration (hundreds of ppm and more) can include: headache; tiredness; nausea; dizziness. Benzene can also cause unconsciousness if exposure is very high (thousands of ppm).

Long-term exposure to lower concentrations of benzene can result in: bone marrow suppression leading to serious blood disorders such as anaemia; cancer – forms of leukaemia and other white-blood-cell cancers.

While most structural firefighter's footwear that meets the Australian Standard 4821 2006 is water resistant or water proof it is not known whether that would stop Benzene being absorbed through the boots.

A US Airforce study into JP8 which is very similar to Jet A1 but with some additives for Military specifications states:

> "We investigated exposures to two important aromatic constituents of JP-8, namely benzene and naphthalene. Although benzene is found at concentrations below 0.02% in JP-8, **it is a known human carcinogen** and is arguably the most hazardous

component of jet fuel. Thus, we wished to quantify benzene exposures among a large sample of persons exposed to JP-8. Naphthalene is an abundant aromatic constituent of JP-8, reported at concentrations from 0.26% to 1%, and has been used as a marker of JP-8 in studies of dermal absorption. Although naphthalene has recently been shown to cause lung tumours in mice and may represent a health hazard in its own right". Egeghy. P, Hauf-Cabalo. L, Gibson. R, Rappaport. M, (2003)

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