ENVIRONMENT, NATURAL RESOURCES AND REGIONAL DEVELOPMENT COMMITTEE

Subcommittee

Inquiry into the CFA training college at Fiskville

Melbourne — 29 January 2016

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Witness

Dr Tee Guidotti, international consultant in occupational and environmental health, risk science and sustainability *(via videoconference).*

The CHAIR — We now open the hearing, and I welcome and thank Dr Guidotti for agreeing to give evidence to the inquiry. I hope we have not inconvenienced you too much, and apologies for the later start than expected. I just have to go through a few formalities before we pass it over to you for your presentation and then our questions. I will just get straight into it if that is okay with you.

Dr GUIDOTTI — Sure.

The CHAIR — Welcome and thank you for appearing before the committee today. In accordance with guidelines for hearings I need to remind members of the public — because we have a public gallery in the room as well today — that they cannot participate in any way in the committee's proceedings and that the gallery should maintain quiet at all times.

Dr Guidotti, as outlined in the guide provided to you by the secretariat, all evidence at this hearing is taken by the committee under the provisions of the Parliamentary Committees Act 2003 and other relevant legislation and attracts parliamentary privilege. Any comments you make outside the hearing will not be afforded such privilege. It is an act of contempt of Parliament to provide false or misleading evidence to the inquiry. If you do not mind, if out of your evidence today further questions arise, the committee may contact you to seek further information or clarification. All evidence is being recorded, and you will be provided with the proof transcript prior to it being made public, just to check it for accuracy.

Once again, thank you for your attendance. Can I just confirm a little bit of background information about you so that we can inform the public? You have quite a fairly extensive CV by the looks of it. Dr Guidotti, you are an international consultant in occupational and environmental health, risk science and sustainability. You trained at the Johns Hopkins medical school after completing medical school at the University of California, and you also did an undergraduate degree in biology at the University of Southern California. You have published many papers on numerous topics around the area of occupational and environmental medicine, toxicology, ecosystem health, sustainability and health, and also science policy, and I understand that you were engaged by the Australian Department of Veterans' Affairs to undertake a study of servicemen and women in the RAAF in relation to, I think, the Point Cook facility here in Melbourne. That is all correct?

Dr GUIDOTTI — Yes, that is correct.

The CHAIR — Okay, thank you. Now we can pass it over to you. We have a copy of the slides that you provided to us. We have a hard copy, and I think they are also going to be put up on the screen just below our video of you. I pass it over to you. Please begin when you are ready.

Dr GUIDOTTI — All right. First of all, I would like to thank the committee for asking me to appear to discuss this important topic. I have devoted a great deal of my career to issues related to this, not only because of devotion to the health and the fair treatment of firefighters in their profession but also because the issue of occupational disease frequency among firefighters is, I think, a very important case study that informs issues of occupational disease and compensation in general. Because firefighters have been so well studied, we have so much information about them, and yet there are still issues to be resolved. Resolving them for firefighters advances the whole field of occupational epidemiology, and that was an additional dimension of why I became so interested in this occupation.

For the purposes of this hearing or this inquiry I did not want to spend a great deal of time talking about individual cancers and individual justification for presumption. My colleagues and I — and I want to be sure that you see it on the screen — have produced a book that I am holding up right now called *Health Risks and Fair Compensation in the Fire Service*. In it we go through all the various significant occupational diseases issues, including a chapter on cancer, and we talk about the evidence for general causation for those major causes. You have a presumption table that has been developed for other jurisdictions in Australia and that I understand is under consideration for Victoria. I do not intend to go through all those cancer sites. I thought that it would be more useful to you, particularly as legislators, to hear a presentation on the rationale behind the evidence in its totality and how our thinking has changed on firefighters and the evaluation of cancer causation. That is what I am going to concentrate on in this presentation.

I assure you that I am not going to go through 31 slides individually in detail; I will spare you that. However, you will have this presentation, or you do have, in hard copy so that your staff and the public record can see in greater detail than I am going to express today what the background is to the things that I am going to be saying.

The next slide, slide 2, talks about the obvious. By 'the obvious' I mean that it is entirely, perfectly understandable that firefighters are exposed to many carcinogens at high levels of exposure. The reason for that is in large part because of the products of combustion that generate large quantities of carcinogens that we will talk about in a moment. In addition, there are other sources of carcinogenic exposure that are associated with firefighting, and we will talk briefly about that as well. The plausibility of elevation of cancer in firefighting is not questioned. The exposure to carcinogens ranks very high for any civilian occupation.

The next slide goes into the issue of what we do to reduce that level of exposure. We know that there is a high degree of exposure not only to carcinogens but also to acutely toxic chemicals in fire smoke, and these present an operational risk to firefighters in their work as well as a long-term health risk in terms of cancer and other chronic disease. So in recent years personal protective equipment has been refined and developed. If you want to see how far this technology has gone, I recommend going to the fire museum in Melbourne. It is a superb demonstration of how this technology is advanced, because they have models of the early efforts to protect firefighters and you can see how difficult they were to use and to put on.

Modern equipment is much more effective; however, it is still limiting. It is limiting because when a firefighter is in a smoky structure that is burning all around him or her and the structure may be weakening, it is difficult to see through the face plate. They can only be worn effectively for a limited period of time. The practical implication of that is that although the respiratory protective equipment is very effective at reducing exposure, it does not completely prevent exposure to combustion products from occurring. That occurs when the self-contained breathing apparatus is taken on and off. It also occurs through the skin. One of the things we have learnt recently is that in addition to being inhaled, some exposures, particularly to chemicals that are carcinogenic, can occur across skin at toxicologically significant levels.

The doffing of fire gear typically takes place after the fire has been knocked down. That is highly problematic, because at a time when firefighters are searching for burning embers, they are least protected but the generation of potentially carcinogenic chemicals is actually quite high when the fire is actually smaller. During that phase, which is called overhaul, firefighters have in the past been potentially as much or more greatly exposed to exposure than while the fire is actively burning.

I mentioned that the self-contained breathing apparatus presents a potential hazard. It is difficult to manoeuvre while wearing it in a burning building that is filled with smoke. It also changes the centre of gravity of firefighters, and it is hot and uncomfortable. For all of these reasons there is a practical limit of time, and you can only expect firefighters to tolerate the respiratory protection for so long. In addition, when you are at the fire scene, if you can smell smoke, you are inhaling some degree of combustion products that may be carcinogenic, because after all that is what is in smoke. So it is a matter of degree of exposure. It is not a matter of whether exposure occurs.

The next slide talks about additional causes of exposure. Again we have become much more aware in recent years that there are other sources of exposure besides the fire ground that confer some exposure to firefighters — for example, diesel exhaust. In fact diesel exhaust is probably the primary example, although there may be solvents used in cleaning and so forth that also contribute. Diesel exhaust contains carcinogens, and it contains carcinogens that exist in fire smoke but also some additional compounds called nitroarenes that have been associated with lung cancer that are separate from what you would get in fire smoke. Diesel exhaust has emerged as a significant additional issue that was not taken into account 5 or 10 years ago. By the way, these are bona fide recognised carcinogens, not speculative.

The next slide talks about lifestyle confounding factors, and the points to be made here are two. For certain outcomes, such as cardiovascular disease risk, I often get asked, 'Couldn't firefighters reduce their risk?', or, 'Why should a risk be associated with things that are modifiable in diet and lifestyle?'. The short answer is that lifestyle is part of being a firefighter because of all the time spent in a fire hall. The lifestyle of being a firefighter is significantly modified by life in the fire hall. In addition to that, the fire hall, where firefighters spend so much time, contains atmospheres, such as intrusion from diesel exhaust, that may confer additional exposures. That includes the outgassing and material that is deposited on the bunker gear that may be in the fire hall atmosphere. Just because a firefighter is not at a fire all the time, every day, every week does not mean that they are not placed at risk because of the lifestyle they choose as a firefighter. That is the first one.

The second is that firefighters in general are very fit. They have very low smoking rates — in fact there is one paper from South Australia that is just astonishing about how low the smoking prevalence is — and they ought

to be at low risk for many of these health outcomes, including many cancers. However, their mortality profile does not reflect this favourable lifestyle profile. Why is that? I think we now have a much clearer idea of why it is that firefighters do not have better health, not counting traumatic incidents and traumatic injuries, than they ought to compared to the general population. They ought to be much better than the general population. They are not that much better. Why is that?

The next slide shows the reason we think explains it, and that is that the elevated occupational risk is offsetting what ought to be a favourable risk from good lifestyle and low smoking prevalence. When you see the mortality or the cancer incidence rates for firefighters, you have to consider that based on their lifestyle risk, firefighters ought to be much better than they are. The analogy I like to use is what happens when you have a valley and you build a tall building in it. The tall building represents risk. If you look from the mountainside, it does not look like the building is very tall, but if you go to the base of the building, you can see that it is very tall. The reason it does not look tall is the valley. In this case the elevated risk for firefighters is superimposed on a lower risk from lifestyle issues that should be in the favour of firefighters but that is offset. Failure to understand that led to a lot of confusion. People might say, for example, 'The risk isn't elevated' or, 'It's only elevated a little bit', but it ought to be reduced from the reference population. It took a long time to figure that out.

The next slide talks about different standards of certainty that are applied in adjudication. Frequently people will say that we do not have enough evidence, usually for a particular cancer, to say with absolute scientific certainty that it is elevated in firefighters. My response to that is: nobody is asking for that, or nobody should be asking for that. The standard of scientific certainty is not reasonable in a situation like this. First of all, it is unattainable, because in order to be absolutely sure you would have to remove all elements of doubt, which you try to do, applying the scientific method; you cannot do it to human populations, with all the uncertainties, with differences of exposure and with statistical uncertainty — in other words, random error that occurs from one study to another.

The standard that is used throughout the commonwealth for issues of civil matters is the weight of the evidence — in other words, the balance of probability. We have looked at the evidence from the standpoint of its weight, its balance of probability. Seen from that perspective, you get a rather different picture. There is a great deal of literature on firefighters, and there may not be 95 per cent certainty but the weight of evidence shows quite clearly that it favours a wide range of cancers as being elevated, and quite plausibly, when you look at the exposures.

The shift to balance of probabilities is something that has dramatically changed the way we look at these things. By the way, a balance of probability roughly coincides with a relative risk of 2. I will not go into the mathematics for that. It corresponds to even odds, which corresponds to 50 per cent probability, which corresponds to the tipping point for weight of evidence.

The next slide talks basically philosophically. The issue is that our methods for looking at these problems through epidemiological studies require interpretation: if you apply a study, design a sort of cookie cutter and look at the summary response, you are going to be missing most of the information of the study. When I look at a study, for example, I look at whether there is evidence for an exposure response — in other words, individuals who are in situations where they are more highly exposed ought to show a higher frequency or risk of the outcome, usually a cancer in question. And I look if there are other indicators suggesting there is an issue, and whether they fit a pattern. The pattern, I think, is what is critical here.

Too often I see analyses being done that sort of put numbers from several studies in, turn the crank and get a summary number, which I do not think is very useful. Because I think a lot of studies that are better designed are mixed with studies that are less well designed. Studies that have statistical power and that capture the risk or that have low statistical powers and by chance capture the risk are diluted with studies that did not and so forth. I think part of the problem is that we need to learn to look at epidemiology more critically in different ways and to be more nuanced in our interpretation of the data.

The next slide shows kind of a glossary of key terms. For example, when I use the word 'power', I am not talking about the strength of a study in terms of how it is designed; I am talking about a statistical number, and that is the probability of detecting an elevated risk that is actually present.

When we talk about the numbers in a study, this is what we are talking about. There are many studies out there that have too low power to predictively capture a risk that in fact is present. So you do not expect every study to

have the same outcome. Power varies from study to study. Studies that are designed to look at the health of a large population are built or constructed on the basis of their power to detect major outcomes. That means that when you get into cancers, particularly less common cancers, they tend to be tremendously underpowered. This means that if they show something, it is unusual and it should be taken very seriously compared to studies that do not show it, because the outlier is actually telling you something, because it is showing something that is unlikely to happen.

I will not go through the rest, but these terms mean something to me as a health scientist that may mean something different to you. I gather that many of you have a background in law. You have a notion of what 'presumption' means. To me presumption is based on a statistical concept that, all things being equal, when a claimant comes forward, they are far more likely than not to have had their condition arise from firefighting. So I look at the evidence for that number: is it close to 2 — is the elevated risk close to 2 — and does it show causation evidence consistent with an exposure response? And then I recommend that it be considered for causation or considered as a candidate for presumption. Others may have other ways of approaching the problem.

The next slide talks about some of the changes that have brought about what I would consider a small revolution in looking at firefighter studies. For example, we now understand a lot more about the potential carcinogenic hazard of many of the chemicals that we know firefighters are exposed to, such as diesel exhaust. We have identified nitroarenes in diesel exhaust, and we know that this previously overlooked chemical, PAH, is very much associated with certain types of cancer. We know that trichloroethylene, which in the past was almost entirely considered a solvent — kind of a nuisance — in hazardous waste, is formed in fires where there is a chlorine source, as there is with polyvinyl chloride. We know that firefighters inhale atmospheres that contain this particular chemical that we were not thinking about five years ago. Likewise we know that certain chemicals that we knew were there all along, like benzene, have a higher potency in terms of being a carcinogen than we really appreciated just 10 years ago.

This has caused us to look at these studies in a different and I think more critical and appropriate way, with the weight of evidence and close examination of internal evidence with things such as the exposure-response relationship. It is a more appropriate way of looking at these for compensation qualification purposes than in traditional occupational epidemiology, where we are looking more for scientific certainty and for other patterns.

The next slide talks about the four major problems in interpretation. I am going to just outline them and then very briefly look at some of the ways of approaching them. I talked about power. If you have too small numbers, you cannot find that needle in a haystack. Every study has its limitations, and some studies have built-in issues involving bias. For example, if only certain types of cancer are reported for a particular statistical source and others are omitted because they are overlooked, that is a potential source of bias. That is not the same thing as power. Power is a statistical issue, where there are either enough or insufficient numbers to show something on a statistical basis.

Aggregation is another big issue. In the older studies of firefighters especially, many diseases were lumped together into one single category, and this had the effect of diluting — this is shown in the next bullet point — the risk for the major diseases in that category. So by lumping together diseases that may, but also may not, be associated with firefighting, on many of these outcomes that seemed low then, we are seeing evidence for an elevation because they were inappropriately aggregated and because the actual risk that was there was diluted by the inclusion of things that were not associated with firefighting.

Then finally we have confounding. Confounding is when you have a second risk factor, and this second risk factor is confusing the issue because it has some relationship to the risk factor you are interested in — in this case firefighting — and some relationship with the outcome, such as cancer. The classic confounding factor in occupational epidemiology is cigarette smoking, because that is associated with socio-economic class, which links with occupation, and it is also associated with the outcome, which is cancer. Getting a clearer picture of how things look when you subtract out confounding is really important. In Australia you have an advantage, because your firefighters actually seem to smoke less than others in the world, so the confounding is less of an issue.

The next slide shows one framework for approaching these issues, and that has to do with assessing power. The basic message here is that you cannot really go by what is on the surface reported in the abstract of the study, because if you actually look at the relationship to exposure, you can often get a very different picture. For

example, in one study that I often use as an example the risk is only 50 per cent elevated for bladder cancer in firefighters overall, but then when you look at firefighters that have the appropriate length of service, a legacy period that has expired that is appropriate for the disease and where exposure has been significantly documented, it rises to close to 2.6. You can see that getting into the details of these studies is very important, particularly when you are limited by low power.

The next slide shows the aggregation phenomenon that I talked about earlier. In the brain, for example, there is one type of cancer — it is called glioma — that is most likely to be associated with exposures such as firefighting; the others are not. However, it has been common practice to put them all together into cancer of the brain. What that means is that an elevation from gliomas can be diluted by some of these other things that are probably — we are not sure, but probably — less closely associated, and so they may not show up as high an elevation as would otherwise be the case. So an elevation in this category, which we see consistently in studies but not to a very high degree, is probably masking an elevation of the type that is most commonly associated with the occupation.

The same problem is also true for cancers that belong to the families of lymphomas, leukaemias and myelomas. In the past they were all lumped together and reported as one category. We do not do that anymore, but there are any number of leukaemias and any number of lymphomas, and we do not separate them out because they are individually so rare, with myeloma even more so. So it is an issue getting into the structure, the kind of boring details, of how these disorders are coded.

The next slide takes the first incidence, and that is when you have got a lot of little cancers and one big one in one particular [inaudible]. We now, I think, understand that an elevation in the class, even if it is not very big, is telling us something, and that is that there is probably an elevation in the one that matters most in terms of frequency.

The next slide gives the example of brain tumours. I am not going to go into detail on this, but that is the example I would give. The next slide shows the conclusion, and that is that when you have one disease predominating in a class, you basically have two ways of looking at it. The elevation is a signal that something of that class is elevated, and it is often the disease that predominates. You can accept all members of that class. You pretty much have to, unless you have data that shows exactly which member is which, because you have got to be fair to everyone who is applying. But that is one problem that needs special attention.

The next slide shows the other case that I mentioned about aggregation, which has to do with when you have got a collection of diseases that are individually rare that are aggregated into a group, but you do not have any one predominating. The next slide shows examples of how frequently you see this problem with leukaemias, which are an aggregation of about 12 different cancers; lymphomas, which are an aggregation of about 35 different cancers; and myelomas, which are actually biologically a form of lymphoma, but we will not go into that.

If you look at these categories, we are doing better by separating them out into families, but those families still have a lot of members — individual diseases. If you have an elevation, it is very difficult to sort out which is elevated, because they are not common — because they are rare. Acknowledging all the diseases in that category is more or less the default that you have to fall back on, because you cannot pick them out because of insufficient evidence. The next slide shows exactly how many lymphomas there really are. We do not have nearly enough evidence to develop a schedule for each of these.

The next slide shows the conclusions. It is usually not possible to identify the specific association. There may be elevations in one or more individual diseases; it is difficult to prove, but you can often infer because of the chemicals that you know are associated. So it is a question of the weight of evidence. If you do not have a smoking gun, you really need to accept the elevation of the class, because otherwise you are being unfair to a person who has claimed, in the absence of evidence, because you are simply lacking the evidence. You cannot get to the first case evaluation, because there is not enough evidence to get to the first case, and that would be true, for example, for many of the rare lymphomas.

The next slide talks about the last framework, and that is what to do when there is confounding. How can you separate out the risk? The short answer is with some difficulty. The next slide shows an attempt to do this. It is more of a conceptual approach to it — that is, if you look at the risk as individual building blocks, there is a building block from just living in a community. That building block is typically the same as the reference

population, because we usually choose a reference population that is the same as the community the firefighter lives in. That is the first building block. The second building block would be personal lifestyle factors, and I mentioned that for cigarette smoking for firefighters, particularly in Australia, that is smaller than it would be for other populations, such as the reference population. Then the third building block would be the risk from the second cause, which is firefighting.

To the extent that you can separate them out statistically, the questions are: can you compare the size of the bricks, is occupation significant and does it give you evidence for a causation? The next slide shows an attempt to do that that I personally think is persuasive for non-smoking firefighters. I do not have any better idea than anyone else what to do with smoking firefighters, but typically, again, firefighters smoke less, so their risk would be greater than the reference population, even among smokers.

The next slide shows some of the math involved — very simple. The next slide shows that if you do it two different ways, you get the same calculation, so it is reassuring.

The next slide shows the framework. There is an elevation in risk for firefighters that is independent of smoking. The whole issue of smoking also comes up when you say that somebody should not qualify because they smoke, yet if smoking was not an exclusion criteria at hire, then there is a question in my mind of whether smoking should be held against an individual claimant. Anyway, models have to be used here because we really do not have the evidence to apportion smoking at the lower levels of smoking that you see in, say, the population of firefighters.

I presented four conceptual models to get around the methodological problems that we have. This has been a foundation for a revolution in the way we think about the occupational hazards of firefighting. Am I making this up? Is this something that is a minority opinion, or is it reasonably well accepted? I would like to suggest to you that it is standing up to scrutiny. The essential statements in the presentation I have just given you have been peer reviewed, they have been published, they have been presented publicly at international meetings, and they have held up. Scientific certainty would be great. We are never going to achieve it in something as complicated as this. A decision has to be made, whether there is certainty or not. The appropriate standard, I believe, is more likely than not — and that is certainly at the civil litigation standard, not scientific certainty.

The next slide talks about the practical problems of dealing with this, and I apologise for that — that is, there is random error in all of this. That is one of the reasons why one study, especially an under-powered study, is quite likely to show a difference than another study, and you do not expect all studies to show exactly the same result. It is because there is random chance. You are rolling the dice in each case, and you are getting an add-on of random chance about whether you are going to see the risk or not. As a consequence you cannot tell the difference between a relative risk of 1.7 and a relative risk of 2.0; you cannot split the hairs that finely, because of the statistics.

You can look at bias and see if there is an error that consistently elevates or consistently reduces and underestimates the risk, and take that into account, but almost all sources of bias, power, and confounding that affect occupational studies of firefighters tend to underestimate the risk, particularly in this classification bias where you are not correctly assessing the exposure. So you are more likely to get an underestimate than an overestimate when you are analysing these studies, and that is another reason for confidence in interpreting them by the weight of evidence.

It is possible that certain forms of bias will overestimate a risk estimate, but it is extremely uncommon. It occurs in some forms of risk classification bias that we are seeing in a study like this. Even so, epidemiology is a blunt instrument — 1.7 cannot be distinguished from 2.0 — so it is guidance. It does not completely solve the other problem; these things have to be interpreted, and again, as I have said several times before, most studies that we rely on actually do not have enough power to do fine risk assessments or parse rare outcomes, like rare cancers, with any degree of, say, differentiating from 1.5 and 2.0, or to 2.5. You cannot make such fine distinctions; you can only say with some level of assurance that it is elevated or it is not elevated.

On the next slide, as I come to the end, are general considerations. Firefighters are at risk for a variety of specific cancer outcomes. I think the general causation needs to be based on the totality of evidence — not summary statistics that somebody publishes in an abstract, but actually digging into the study, and that is what we have tried to do. Not all studies are equally good — they all require some interpretation — and this is general causation. When you are talking about an individual claim, you need to look at the specifics of that case

and the specific causation based on all the factors that you are familiar with, with the rebuttal of rebuttable presumption. I am not going to say any more about that because most of you, I suspect, are very familiar with this and are probably more familiar than I am.

The next slide talks about specific conclusions. I would urge you, in your deliberations, to consider a system in which you can add scheduled outcomes, because the literature on firefighters continues to evolve. There will be new data, and there will be additional studies. Not every new study invalidates every old study — in fact, to the contrary. The weight of evidence may not necessarily be changed by a new study that is not confirmed and that has not been extensively interpreted. You are very fortunate; you have the study that was done by Monash. It is a superb study, and it is specific for Australian firefighters. That gives you a huge advantage that other jurisdictions do not have. Scientific certainty is not practical; we have talked about that extensively already. Therefore I think it is reasonable to establish a rebuttable presumption. I am aware that that is on the table before you and under consideration. I think that is the end of my slides, if I am not mistaken.

The CHAIR — Yes, it is.

Dr GUIDOTTI — I hope that gives you an idea of the context and why we are now talking about this in different terms than we may have talked about risks for firefighters 5 and 10 years ago.

Ms WARD — Thank you.

The CHAIR — Thank you, Dr Guidotti. I think I speak on behalf of all committee members in saying that presentation really does address a lot of the questions and issues that we are grappling with as part of this inquiry. As you know, we have more narrower terms of reference in terms of the Fiskville training centre and the firefighter training that was done there, but of course presumptive legislation has come up time and time again — and that is, of course, one of the remedies.

I will start off with a few questions that relate back to the narrower circumstances that we are dealing with, but in doing so it will probably bring up some of the issues you have raised in your presentation as well.

Dr GUIDOTTI — Could you please move the microphone a little closer to your face, because I am having just a little bit of trouble hearing you?

The CHAIR — Sorry. Is that better?

Dr GUIDOTTI — Yes, that is better.

The CHAIR — I guess the first question for us is: are you familiar with the CFA training centre at Fiskville and at what has been going on there and the sorts of activities that have been conducted there?

Dr GUIDOTTI — Well I cannot answer that question because I am not personally familiar with the situation at Fiskville. I am aware that it was a training centre, I am aware that there were chemical exposures. Although I was involved in reviewing some of the evidence for Point Cook, I have not been involved in reviewing any reports or evidence from Fiskville, so my interpretation is not really informed.

The CHAIR — Okay. The questions we will ask are more general in terms of your expertise, but I suppose we will put them around the context of Fiskville. But I will explain that as we go, if that is okay with you?

Dr GUIDOTTI — Well I can tell you that there is a somewhat analogous situation in the use of burn pits in military operations in South Asia and a great deal of interest in that. So the types of things that are generated from the combustion of waste, the combustion of diesel fuel and other fuels in situations that are analogous to training programs are becoming better known and better characterised. I think that training situations are intended to provide a worst-case scenario to allow the firefighter to cope with whatever is thrown in their path and, as a consequence, smoke tends to be particularly dense and the situations or the hazards tend to more accurately reflect a severe fire than a typical fire. So I think I would expect the same to have been the case in Fiskville.

I am also aware that some liquid waste was combusted at that location. I do not know the details. That is a precarious and fraught situation wherever it occurs, so I hope more information is forthcoming, but I do not have any information that would allow me to comment.

The CHAIR — Okay, thank you. I am just trying to understand. At the Fiskville training centre we are dealing with a number of components. The first is what is called the historical contamination where there was the burning of sump oil, diesel — —

Ms WARD — Solvents.

The CHAIR — various solvents, unknown chemicals and maybe mixtures and expired-date chemicals that were used in fires. The second part is then the contamination around the firefighting foams that were used in training to put out the fires, so it is the perfluorinated chemicals. The third aspect is the water quality that was used by the trainees, and that again was water that was contaminated with both the old chemicals, because it was recycled, as well as the residues from the foam and then of course things such as E. coli and other bacteria. You probably know the background to all those chemicals that we are talking about here.

Dr GUIDOTTI — That is certainly a complicated issue. Starting with the easiest one first, the water quality would normally be concerned with skin absorption. We now know that fire turnout gear, particularly when it is wet, does very little to protect skin and we know that absorption across the skin is significant from any of these chemicals. Without knowing the source of the water and degree of contamination, it is hard for me to comment, but in terms of the inhalation risk I think that the — —

In situations like this you always have to be concerned about the collaboration of dioxins and furans and other compounds wherever there is a chlorine source and you are burning hydrocarbon-based fuels, which would frequently be the case when you are dealing with waste materials. That can lead to widespread ground contamination and a potential hazard for workers who are cleaning it up. Again, if you are talking about soil contamination, largely through skin. So there is [inaudible] people who work there, hazards for the firefighters who train there and some degree of a cumulative risk for the people who may have rotated in and out as training instructors. So it would be a complicated situation but the potential certainly is there as you have described it and [inaudible] a limited standard of widespread significant contamination.

The CHAIR — And these chemicals — a number of them are considered carcinogenic and would be the types of things you would look at in terms of presumptive legislation as I understand it. Is that right?

Dr GUIDOTTI — I lost the signal there for a minute. You are saying that the — —

The CHAIR — We understand that a number of the chemicals that people were exposed to at the training site are known to be carcinogenic and that in terms of presumptive legislation these are the types of chemicals and the contacts that would be part of any presumptive legislation schedule of disease.

Dr GUIDOTTI — Yes. The authoritative world body for deciding whether a compound is [inaudible] carcinogenic or not is the International Agency for Research on Cancer. We colloquially call it IARC. IARC is a remarkably thorough agency in evaluating all of the evidence. But IARC is also fairly conservative, so when IARC declares a chemical to be carcinogenic you can be quite sure that the laboratory and the immunological evidence are confirmatory. If IARC says that it is a probable human carcinogenic based on cumulative evidence, history has demonstrated that it is very likely to be in the end demonstrated to be a human carcinogen, because the natural history of IARC is such that they almost always call it right.

There is another element to my answer to your question beyond IARC — —

The CHAIR — Can I just also ask then while you are thinking about that — PFOS and PFOA, what is your view in terms of the human health aspects? What do you think the effect of PFOS and PFOA is in terms of human health?

Dr GUIDOTTI — The effects on human health at Fiskville?

The CHAIR — The perfluorinated chemicals. Do you believe that the perfluorinated chemicals used in firefighting foams are a risk to health?

Dr GUIDOTTI — I did not quite hear you.

The CHAIR — Maybe I will try another microphone. Is this one better?

Dr GUIDOTTI — Yes, that is better. It seems to be.

The CHAIR — My last question was around the perfluorinated chemicals PFOS and PFOA —

Dr GUIDOTTI — Yes, PFOS.

The CHAIR — and just to ask your opinion as to the human health effects.

Dr GUIDOTTI — Yes. I think that like other halogenated hydrocarbon chemicals they do have health effects and I think they do present a risk, so I would put them in with the other halogenated hydrocarbon chemicals as being confirmed.

The CHAIR — And in terms of your presentation and how you determine risk and the causal link, could the health effects as a result of PFOS and PFOA exposure be dealt with under the regime you have outlined in your presentation?

Dr GUIDOTTI — Yes, certainly, yes. Just because I have not mentioned it in the slide that has to do with chemical exposures, there is an entire chapter in the book I held up on various chemicals and it is far from exhaustive.

The CHAIR — We have heard, and I suppose this is more around the PFOS and PFOA, the human health studies and the toxicology studies and there seems to be in the evidence we have had a lot of concentration on the toxicology evidence and less on the human health studies. What is your view about that? Because you really have not talked about toxicology at all in your presentation.

Dr GUIDOTTI — That is true, because toxicology comes with an entirely different set of problems and I figured that you probably would not want to spend all morning on this. But the proper toxicology has to do with extrapolating between species and what you do with test tube studies that are not done on animals. We are being increasingly curbed on our ability to use animals in research. The test-tube studies, fortunately, are getting better and better. The flora and the sulphonates are certainly demonstrating activity in toxicological screening studies. That is of great concern. I do not think that we have a good body of evidence epidemiologically yet, but I would not wait for it. I think that here is a situation where something akin to the precautionary principle applies. We have lots of information suggesting that these have adverse effects, including cancer risk on mammalian species. I think that we should curb exposure.

Looking backward to cancer rates and trying to establish exactly what it is in this mixture that firefighters are exposed to is daunting and, at the current state of the art, difficult if not impossible. So what we can say is that PFOA and others are certainly part of the mix, the rich mix of percentages that firefighters are exposed to. Exactly which chemical it is in the atmosphere and on the skin that contributes is frankly, to my mind, immaterial, because firefighters are necessarily exposed to mixtures, so if you try to separate them out it is a little artificial in retrospect. Going forward, the animal tests give us a fair idea of what to focus our attention on in terms of prevention, and we know that exposure to these chemicals should be minimised.

The CHAIR — Thank you. I now want to go on to the issue around health studies and health monitoring, because one of the things the committee is looking at in terms of this inquiry is what do we do, because we are talking about not just those that trained at the CFA site but there were families that lived there, there was a school on the site. What do you think — and I know you talk about some of the limitations of data collection and registers and monitoring — but could you give us any advice about how you would see a health register or a health monitoring system that could work in the best possible way?

Dr GUIDOTTI — I think that you would want a register that provides portability, so wherever in the country people would move there needs to be access and a practitioner could understand where they are and develop the real history. In most chemical registries the biggest weakness is exposure assessment. The key problem is almost always how to pin down where the individual was and to what extent they were exposed. In order to establish some kind of a schedule later on as the health outcomes become known, that information is critical and it is usually not collected systematically right at the beginning until people become aware of it and often records are lost or it becomes difficult to reconstruct for individuals. So a registry that focuses on exposure is very valuable in tracking people.

You also, I think, in monitoring and tracking these individuals are well advised to have some method of saving samples like serum and blood for future studies, because we are much further now than we were 10 years ago and 20 years ago and entire families of bio-indicators and genomic testing have developed over the years that we did not have available before. Many of the new genomic studies can give us an idea of which genes are upregulated and which are likely to be associated with if not different chemical classes — because they are not that good — that suggest cancer risk, getting that exposure in the most changed individuals and elevating an individual's personal cancer risk. Having a serum bank or something of the sort or saving blood samples could be very useful, but the single most important thing I would suggest would be to validate the exposure that an individual potentially had as accurately and in as much detail as possible.

The CHAIR — Thank you. I now pass you over to Tim Richardson, who has a few questions.

Mr RICHARDSON — Thank you, Doctor, and thank you for your presentation. It is very informative and I think gives us a good framework broadly on how we have to approach presumptive legislation. One point that you made about whether a firefighter moves around the nation as well is a complexity we have with our different states and different jurisdictions, so that is an interesting point that you make. I want to come to health studies, which has been a significant focus of the committee. We have heard from a range of experts about health assessments and studies and emerging studies, particularly on those perfluorinated chemicals. In particular, in your 2014 report on the air force base at Point Cook you stated that there can be issues with occupational cohort studies and population monitoring studies, particularly health registers and health studies, which is something that is emerging across fire services in Victoria. I am keen to get a sense of those limitations, if you could maybe elaborate further on that, and also what suggestions you might have for our committee about any type of health study we could recommend with our Fiskville example — a health register or something that might be useful for us into the future.

Dr GUIDOTTI — You can imagine five years ago if you wanted to put together a monitoring study for the perfluorinated sulphate, you would not know exactly where to start so you might very well be monitoring for the wrong thing. There are basically two approaches to this. One is in the trade call of surveillance, where you know exactly what you are looking for and you hone in laser like and try to determine whether you have got an elevation in that particular outcome. The other is monitoring, where you have a wide variety of tests that you apply repetitively with a baseline usually several years later and then for the fluoridisation in order to determine what the health experience is over a [inaudible] park and what is showing up as greater than expected. Surveillance is actually technically considered a subset of monitoring, but that is how the two basic approaches work.

I think that one way not to do it is to simply do a prevalence study and do a survey of people in one jurisdiction and then do another survey in another jurisdiction. That tends to be quite crude. It is useful in determining what the health needs of the population might be, and it is useful as a benchmark if you are going to be following both populations forward and looking at their health experience, but it becomes very difficult to interpret — in part because communities that have had bad experiences, which I am sure is the case in Fiskville, often tend to answer health questionnaires a little differently, and that is because they are concerned about their health and so forth. This potentially can introduce biases and people will come back later and say, 'This isn't a real change — it's due to this, that or the other'. You want to design a surveillance system that is robust and that collects the data as accurately as possible. Prevalent studies are usually too limiting and they are only useful as a point of departure in order to support a longitudinal surveillance study, in other words one that goes on over time. I would advise any study that is contemplated to be designed to go forward with the population of the future and not be a one-off.

Mr RICHARDSON — Extrapolating that point out, presumptive legislation and its consideration in Victoria as it stands is for the protection of career firefighters but there is also a discussion about volunteer firefighters who underpin our Country Fire Authority. We discussed this yesterday with a couple of witnesses and the interesting point was the difference between length of service and then a particularly heavy exposure from a particular incident. I do not know if you are familiar with a particular fire that we had at one of our power plants. The Hazelwood mine fire recently resulted in heavy exposure for a number of firefighters in one instance. So how does that contrast with length of service, and what factors are put together in that consideration as well?

Dr GUIDOTTI — Well, first of all an observation. Length of service, age and latency period — in other words, time since the first exposure — are all connected, so it can be very difficult to disentangle those things epidemiologically. But we do have good evidence that a single overwhelming exposure can confer cancer risk in animals and we believe that a single overwhelming exposure likewise ought to be able to confer a significant increase in cancer risk in human beings as well. So from the scientific point of view it is difficult to argue otherwise that a measure of exposure at a point in the firefighter's career that is compatible with latency may well be the event at which their cellular event took place, which later led to cancer. So I think that exceptional exposures do need to be taken into consideration.

Career cumulative exposure, though, can easily confer multiple insults over a longer period of time, many of which are cumulative so that the risk of cancer in the long-term is the sum of all of these individual exposures. I do not think we know enough toxicologically to be able to say whether one big exposure is equal to x number of small exposures, and the key scientific issue that we are lacking here is there is heredic repair — that cells that are damaged in the very specific way to DNA that result in cancer risk are almost always fixed by enzymes in the cell that correct the damage. So the great majority of cells that are injured by the carcinogens that are in fire smoke getting into the DNA, put in easy terms, are corrupted. It is that tiny, tiny percentage that escape in which the effect is not corrected that the cancer risk comes from.

Mr RICHARDSON — That is very helpful.

Dr GUIDOTTI — Whether that happens when you have a lot of cells that are affected and very few escape in one big event or whether there is recurrent exposure to the carcinogen and one escapes in one of those events is more or less equivalent in terms of cancer risk — it is a question of the strength of the repair enzymes, and I do not think we have a clue how to factor that into the risk equation.

Mr RICHARDSON — No, and that is an interesting point, because our Monash University in Victoria did a study of Fiskville particularly and had category risk ratings of high, medium and low. One of their findings that had a lot of caveats on it was about volunteer firefighters having a relatively low risk, but I think some of those other factors that need to be considered broadly in there and how you track that in their service are really important as well. It is interesting.

Dr GUIDOTTI — Volunteer firefighters have a very different exposure profile from career firefighters, so I think the data show a pattern and your study confirmed that. We have actually been talking about that for a long time, and the Monash study was quite good in showing that there was a very different cancer risk profile and that difference of cancer risk profile, I think, comes from the fact that the exposure in the volunteer fire service tends to be drawn out and less frequent. So the real question is, 'Has there been a sufficient exposure in that group?', when an individual claim comes in, to apply the lessons that have been learnt from career firefighters, because, with the exception of the Monash study, virtually all of the information we have is on career firefighters. Their cancer risk may well be an overestimate of the cancer risk for volunteer firefighters who are not fighting fires that extensively.

Mr RICHARDSON — Thank you, Dr Guidotti. Just getting to another point, another limitation or challenge for our committee has been the discussion about emerging evidence and papers about various chemicals, and PFOS and PFOA have been focuses of that. But what we have found is that a more cautionary approach has been taken in European jurisdictions, and in particular our experience in Germany was quite significant in seeing a more precautionary approach to community engagement and risk profiling.

I am interested to get your thoughts on the best way for regulators to keep up to date with that evolving evidence, because what we have had as evidence to our committee is that there is no scientific basis for this action to be taken or that action to be taken, but yet other jurisdictions are taking a precautionary approach. The other example is that Australia has not signed up to the Stockholm convention on some of these perfluorinated chemicals, so that adds another layer of complexity.

I am just keen to get your thoughts on what regulators can do to try to keep up to date with some of those emerging potential risks.

Dr GUIDOTTI — I think ultimately somebody has to be charged with responsibility for keeping on top of the emerging evidence. But keeping on top of the emerging evidence does not necessarily mean only looking at epidemiological studies, because epidemiological studies are not the whole story.

When you have a risk, as we have in the PFOA and chemicals like that, that extrapolates to human beings it is only sensible to take precautionary measures. The precautionary principle as it is philosophically applied in Europe — which would be that if there is any sign of a risk you proceed very cautiously and may prohibit its use — I think can paralyse innovation and development of new alternatives. So at some point you need to decide what level of evidence is enough. I think that requires taking into account evidence from toxicology and evidence that extrapolates from known structure-activity relationships of other similar chemicals in order to be considered to be safe, rather than trying to tailor an individual regulation for every single chemical.

That has been the focus of regulation in the United States, and frankly it is not working very well, because the chemical-by-chemical regulatory structure has in effect paralysed, for example, OSHA — the Occupational Safety and Health Administration — and I think it is now in deep controversy and challenge for the Toxic Substances Control Act.

At some point generalisations are going to be required and that may mean establishing that a certain class of chemicals is a high risk and needs to be regulated in a certain way. It may mean that certain chemicals of a certain class are unacceptable and a more rigid precautionary principle needs to be put into place, or it may mean that a chemical is indispensable but that risk needs to be controlled, in which case a risk-benefit is used. Usually that is not done on the basis of a law; it is usually done on the basis of a rule. So if you have an agency that can promulgate a rule based on its statutory authority, you have greater flexibility and that may mean greater flexibility in promulgating regulations but it also means it can be applied to — for example, on the presumption schedule — determining when an outcome needs to be put on the list.

Mr RICHARDSON — Thank you Dr Guidotti. I might hand over to my colleague Vicki Ward now.

The CHAIR — Just before we go to the next question, Dr Guidotti, we are going a little bit over time. I wonder if you mind if we continue for another 10 minutes? Are you able to stay a little bit longer? Is that okay?

Dr GUIDOTTI — Certainly, that is fine.

The CHAIR — Great, thank you.

Ms WARD — I am interested in teasing out a little bit more what you just said, which is to give us some ideas for mechanisms for ongoing monitoring of scientific evidence versus weight of evidence and how we could incorporate that into a scheme and keep it going so that there is an understanding of scientific input or output, but there is still a balance regarding weight of evidence as well.

Dr GUIDOTTI — Yes. I think the way that the system operates right now in North America is a good example of what not to do, because typically what happens is an issue — —

Ms WARD — Sorry, could you please repeat that?

The CHAIR — We had some technical problems and could not hear. Would you mind starting that answer again please?

Dr GUIDOTTI — Okay. I think that the approach that I would not recommend is the way that we do it and the way that it started to be done in Canada before the policy just recently changed, and that is that there would be a problem identified. That problem would be the source of a great deal of contentious argument over whether it was a significant hazard or not. Finally, almost inevitably, the decision would be made that it was a significant hazard and then there would be an argument over what level of standard is set. The standard would be adopted, it would be considered to be a standard for all time. That standard for all time would later be re-evaluated in subsequent studies. They would call it into question. Another round of debate would ensue, another standard would be set, again with the assumption that it would stand for all time, and the process would reiterate and the general park of all of these individual chemical debates would be in the same direction, which is that as science improves we understand better what the risks are and as we understand what the risks are we document them and we see more in terms of hazard and we look for regulatory control.

My personal feeling, which is not shared by most people, is that we should be adopting a policy of continuous improvement. If we can reduce exposure to chemicals at every step along the way technologically or by means of best practice, we should be doing so whether we think that the hazard is at one level or another. That is my personal opinion. I think that the only organisation that I know of that action puts that into practice is the

ambient air quality guidelines for the Environmental Protection Agency in the United States, which does have a practice of reviewing and revising the standard over time.

Other than that, I think that the way that most jurisdictions do this is to vest the authority into a body that has a scientific advisory service attached to it that can evaluate the evidence and objectively present options based on a quantitative risk assessment of what to expect in terms of health outcomes for varying options for control. That tends to be very data intensive; it requires a lot of information. That information is often not available, or if it is, it is available second-hand. Frequently it needs to be obtained from other agencies. That presents its own issue — and that is: to what extent would an agency in one country or one state wish to be reliant on a decision made at another agency or are they depending on information developed by another group, since not every jurisdiction is in a position to do it for themselves. So it is fraught with problems but experience, I think, has shown that the general art is that when in doubt you probably need to tighten the regulation. What is needed is a system that allows that without disruption, in which there is a way to adjust the regulatory framework without expensive and disruptive controversy and without changing the entire regulatory structure, and we have not learned to do that in North America.

The CHAIR — Just a quick question about volunteer firefighters, which are firefighters who are in the Country Fire Authority; they are normally in the more regional and rural areas. One of the comments we have had is that often these firefighters have a history as farmers and therefore have a lot of contact with diesel and other toxic chemicals in their work as farmers, particularly some in the older generations. I am assuming from your presentation that the confounding effect comes into play there. Do you still believe that using that sort of methodology you can still look at or separate out or work on those two areas — the exposure at, say, a training college like Fiskville versus exposure to chemicals as part of a previous occupation?

Dr GUIDOTTI — Conceptually yes, but in practice it would be very difficult to do it in the case that you have mentioned because you do not have good exposure information. As I mentioned earlier, almost every regulatory issue and issue of attributing risk to a population flounders, in occupational epidemiology, on insufficient exposure information, and that is one reason why, if you are going to set up a registry, it should take that into account immediately from the beginning as a top priority.

I think that in theory there is also another issue there — and that is, that in rural areas much of the work, or most, if not all, of the calls that a volunteer firefighter would get would be for wildfire firefighting. Wildfire firefighting is mostly of vegetation fuel. Vegetation is what is called cellulosic fuels, meaning that the predominant material that is being combusted is cellulose. Cellulose does indeed produce carcinogens. Cellulose, however, does not produce the same carcinogens or the same degree of carcinogens as you get in a structural house fire or a fire in an industrial zone. Generally speaking, burning wood is less carcinogenic in terms of its total potency than chemicals that might be found inside a burning building, as a broad generalisation, and I am aware that eucalyptus oils can be quite irritating when inhaled.

So putting that all together, and the fact that volunteer firefighters in rural areas may not be called out as frequently, I think their exposure profile is different, and it would be necessary to really look at an individual's participation and the type of fire that they have experienced, because the exposure profile is different.

The CHAIR — Thank you. I understand though that CFA volunteers — in Victoria, at least — do often fight fires other than bushfires, especially closer to the metropolitan area and also out further, so it might be a little bit different. Anyway, thank you.

Dr GUIDOTTI — Well yes, and that is why I prefer to say largely as opposed to all the time.

The CHAIR — Yes, okay. Thank you very much for spending the time with us and presenting today. What you have told us I think answers or puts into a great perspective a lot of the things that we have been trying to grapple with, so it has been really valuable to hear the knowledge that you have. Thank you very much for sharing that with us.

Mr RICHARDSON — Thank you very much.

Ms WARD — Thank you very much for your time and information.

Dr GUIDOTTI — Thank you. Sorry for not being able to be more forthcoming on the specific matter of Fiskville. I just need to know more about it to comment. Thank you.

Ms WARD — Of course.

The CHAIR — Sorry, I was not questioning that when I asked. It was really so that we did not repeat what you already knew when asking questions. Thank you.

Dr GUIDOTTI — Sure.

The CHAIR — The hearing will now adjourn for 15 minutes and recommence at 11.00 a.m. in the Parliament House Legislative Council Committee Room.

Witness withdrew.