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SENATE

RURAL AND REGIONAL AFFAIRS AND TRANSPORT REFERENCES COMMITTEE

Reference: Air safety - BAe146 cabin air quality

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SENATE
RURAL AND REGIONAL AFFAIRS AND TRANSPORT REFERENCES COMMITTEE

Tuesday, 14 March 2000

Members: Senator Woodley *(Chair)*, Senator Crane *(Deputy Chair)*, Senators Ferris, Forshaw, Mackay and O'Brien

Participating members: Senators Abetz, Bartlett, Boswell, Brown, Brownhill, Calvert, Chapman, Coonan, Crossin, Eggleston, Faulkner, Ferguson, Gibson, Harradine, Hutchins, Knowles, Lightfoot, Mason, McGauran, McKiernan, McLucas, Murphy, Payne, Tchen, Tierney, Watson and West

Senators in attendance: Senators Crane, Forshaw, Mackay, O'Brien and Woodley

Terms of reference:

To inquire into and report on:

(a) the impact of Airspace 2000 on airspace users, operators and providers, including its safety implications;

(b) the application of competition policy to services provided by Airservices Australia;

(c) the impact of location specific pricing; and

(d) the examination of air safety, with particular reference to cabin air quality in BAe146 aircraft.

WITNESS

Committee met at 8.00 a.m.

van NETTEN, Dr Chris, Associate Professor, Faculty of Medicine, University of British Columbia; Chair, Division of Occupational and Environmental Health, Department of Health Care and Epidemiology, University of British Columbia; and Faculty Member, School of Occupational and Environmental Hygiene, Faculty of Graduate Studies, University of British Columbia

CHAIR—I welcome everyone to the public hearing of the Senate Rural and Regional Affairs and Transport References Committee and declare the hearing open. The inquiry was referred on 22 March 1999 and the committee is likely to report in April or May. This is the sixth public hearing on this matter and we are taking evidence from Dr Chris van Netten via videoconference link-up to Canada.

A *Hansard* transcript of the proceedings is being made. The *Hansard* will be available shortly in hard copy format from the committee secretariat or via the Parliament House Internet home page. It should be noted that the committee has authorised the recording, broadcasting and rebroadcasting of these proceedings in accordance with the rules contained in the order of the Senate of 23 August 1990 concerning the broadcasting of committee proceedings.

Before the committee commences taking evidence, let me place on record that all witnesses are protected by parliamentary privilege with respect to submissions made to the committee and evidence given before it. I underline the fact that parliamentary privilege means special rights and immunities attached to the parliament or its members and others necessary for the discharge of the functions of the parliament without obstruction and without fear of prosecution. Any act by any person which may operate to the disadvantage of a witness on account of evidence given by him or her before the Senate or any committee of the Senate is treated as a breach of privilege.

I welcome you, Dr van Netten. Would you like to make some opening remarks and then we can move to some questions.

Dr van Netten—I am glad to do so. In relation to my qualifications and my background, I have done extensive work in the area of air quality. I have measured air quality within a variety of different situations, anywhere from buildings that are supposed to have had cancer associated with them to automobiles which it is claimed have had a problem, to BC transit buses and a variety of other agents that had any air quality problems associated with them. My opening statement is as follows.

I have had the advantage of reading the proceedings of the committee that you people are involved in and, consequently, I realise there are many questions that have arisen over the last four sessions. Rather than making another laborious introduction and statement, I thought I would identify some of the main components, address them and then we can deal with them one at a time. I hope this is acceptable to you.

CHAIR—That would be very helpful. That would be very good.

Dr van Netten—In that case I will start at the beginning. First of all, I have had the advantage of reading the proceedings today and, rather than making yet another opening statement, I have made a series of notes regarding a variety of questions that have come up. I will address these in sequence and offer my perspective on these questions.

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Question No. 1: why is it that passengers do not complain, whereas the flight attendants and the pilots do, in situations where there is an oil seal failure incident? There are a couple of good reasons for that. First of all, the flight attendants and the passengers are serviced by air coming from engines 3 and 4, whereas the pilots are serviced from engines 1 and 2, in general. In respect of the flight attendants, I identified in 1996 in my report to AirBC that there is definitive air stratification within the aircraft. In other words—and I have checked this out in an aircraft with an oil seal failure—if you stand up, you will literally have your head in the smoke, whereas if you sit down at passenger level you will have, relatively speaking, clean air. There is this definite layering effect within the aircraft.

I understand that British Aerospace is trying to fix that in some of the aircraft by getting rid of these stagnation areas. That is okay for general air quality but if you have an incident in the air where there is an engine oil seal failure then basically what you are doing is making sure that not just the flight attendants are exposed to the smoke and whatever else but the passengers are exposed as well, so this is creating another problem. It is not dealing with the main issue, which is smoke in the cabin.

Also, another area that is very important is the physical activity associated with the flight attendants. They are the ones that are walking around and doing things and serving the passengers; this is not the case with the passengers themselves. Occasionally you find also there are arguments between the flight attendants and the pilots. The reason for that is that the pilots have their own fresh air supply compared to what the flight attendants are exposed to. This creates some problems, because the pilot says, ‘I'm fine. There’s no problem here,’ whereas in the back of the aircraft a serious problem is developing. So we need now basic education and communication between the pilots as well as the flight attendants.

The pilots get air from engines 1 and 2 under normal conditions, so they usually get more fresh air than the flight attendants do. This creates a problem by itself. If the aircraft is flying under normal conditions without any problems, they get fresh air and everything is fine, but as soon as you get an oil seal leak in engine 1 or 2 then the pilots get higher exposure than anybody else because they get more fresh air. This fresh air is highly contaminated with whatever comes out of these engines when the oil seal is broken, and consequently pilots get problems first. Under those conditions, the Swedish incident is a good example of that very issue.

That is basically my first point and we can discuss that point, if you want to do so, before we go to the next one. We will take one at a time. I have four points altogether and then I am open for all kinds of subtle questions if necessary.

CHAIR—I will just check with the committee. That seems very clear to me. Do the committee want to ask any questions at this point?

Senator O'BRIEN—No.

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CHAIR—No, keep going. That has been very helpful already.

Dr van Netten—Then I will go to the next point, and that is the question that has come up regarding whether the oil is safe or unsafe. We should realise, of course, that these engine oils are designed for a specific purpose, the purpose being to keep the engines running while you and I are flying in aircraft. If you start changing the composition of these oils, you want to make sure it is to better the performance of the oils rather than to better the performance within the aircraft when you smell, perhaps, the contaminants coming from them. The point that I am trying to make is that we need some commonsense here as well. The oil is there for a specific purpose, to keep the engines running, and they are not meant to go into the air of the aircraft.

A typical example perhaps is when you compare it to your automobile, when you drive your automobile tonight when you go home and you smell gasoline fumes. We know that gasoline fumes are highly toxic. They have a high concentration of benzene, which we know causes leukemia. We also know there is a high concentration of hexanes and other agents that can cause peripheral neuropathy, meaning it will actually destroy the nerves in the arms and legs. What happens, for instance, if you drive your car home and you smell gasoline fumes? Who do you blame? The gasoline manufacturer? Or do you blame the car manufacturer? We could say the same type of thing with respect to the oil manufacturer as well. The oils are not designed for inhalation, the oils are designed for the engine. It is just sad that we have to be exposed to these things because of some engineering flaw, perhaps, that allows these oil ingredients to enter into the cabin.

Now that we are faced with the fact that these oils do enter the cabin because of the physical conditions of the aircraft. Consequently, we do have to address their toxicity, and what really needs to be addressed is their inhalation toxicity—not dermal, not oral; it is the inhalation that is important in many of these instances. Current standards are based on inhalation experiments in laboratory animals. They use triorthocresyl phosphate and they have a certain range, a certain level, that is acceptable on that basis. The trouble is that many of these jet engine oils contain many compounds.

If you remember, in my submission and my articles I have done gas chromatography analyses of many of these oils and we do find there is literally a forest of peaks associated with Mobil 254 and Mobil 291. Consequently, we have many different compounds which really have not been analysed yet. In fact, in personal communication with Dr Mackerer from Mobil Oil, he suggested that it would be a waste of time to identify each individual component in this forest of peaks and he actually had to resort to a statistical analysis to find out what might or might not be in these oils. It appears, therefore, that Mobil Oil has a rough idea of what the composition is of their oils but does not have a clear picture of the different isomers that might be present.

This is very important when one is dealing, for instance, with a mixture of closely related compounds. I understand Chris Winder has discussed these with you in detail, so I do not want to go into a large amount of detail here, but we have many of these compounds. They are closely related, and changing only a few little side arms on these chemical compounds will have a drastic effect regarding their neurotoxicity. I think it is very important for us to know what is in these oils because if we do not know what all these isomers are we cannot really state anything regarding their inhalation exposures and their toxicity. It is therefore difficult to set inhalation standards unless the appropriate experiments are done on each of these oils.

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The experiments that have been done to date are on laboratory animals with a specific product—in other words, one product at a time, not the complete oil by itself. In real life, such as in an aircraft with an oil seal failure, we have a number of complicating factors. These are the factors: first of all, inhalation exposure to a large number of compounds—and I have identified these compounds in some of my articles—including the pyrolytic breakdown products of unknown toxicity. Also, we know that some of the breakdown products have a known toxicity, and a typical example of that is carbon monoxide. We also can expect sometimes a synergistic effect—in other words, where you get an additive effect or a multiplicative effect which is greater than the individual effects by themselves. We do not know what is going on.

In addition to that, we are having exposures not at sea level atmospheric conditions where there is ample oxygen available but we are talking about a level that is equivalent to an altitude of 8,000 feet, which means that there is a lack of oxygen in that particular area as well. Consequently, what is the toxicity of these agents under conditions which are close to being hypoxic—in other words, a lack of oxygen? We again do not know those answers.

In order to say that a particular oil is safe or unsafe, one needs to simulate the conditions in a particular aircraft and these studies have not been done, so we really have to be careful not to jump to conclusions on very laboratory oriented experiments which have very little bearing to what happens up in the air. Any questions up to this point?

CHAIR—I think there may be. I will just check with the committee. Again, what you are saying to us is very clear. Obviously we have gone over this ground as well, so what you are saying is pretty helpful, I must say.

Senator O'BRIEN—Professor, the description you give of the possible components of what I will call a smoke incident in a cabin still leaves a little question mark with me. That is, we have received evidence that in such an incident there have been circumstances where one flight attendant has complained of severe symptoms and others say they have not experienced severe symptoms but perhaps mild symptoms or none at all. Can you give us your views on why that might be the case.

Dr van Netten—I am glad to do so. Do not forget we are all individuals and we have different susceptibilities and many of the criteria are based on a population in general and the average of what a person can and cannot tolerate. Within the area of exposures we do find a range of people with different sensitivities. If there is no problem regarding the levels of exposure, everybody seems to be quite happy, but when we start getting into an area where it is a threshold type of response, where some people get sick and some people do not get sick, you have to be very careful. Other factors, for instance, could play a very important role to make a person more susceptible than another person.

A typical example, for instance, is exercise, as I mentioned before, and I come to that later on in some of my other points as well. Exercise can increase the amount of oxygen a person requires. For instance, you have hypoxia, a lack of oxygen, before somebody else that is sitting down and not doing anything to any major degree. There are certain types of agents that can modify a person's response, so you might feel quite happy under a certain condition, but I might have been drinking alcohol or I might be on antihistamines and consequently I get a lack of oxygen before somebody else next to me gets it.

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Senator O'BRIEN—When you were talking about the cause of the problem, I think you said it might be an engineering flaw perhaps. I think I know what you mean but, given we have heard about the fact that the air bleed comes through the engine and the oil leak occurs in the engine, is that the nature of the sort of engine or engineering flaw that you were talking about, or is it more fundamental than that?

Dr van Netten—You are quite correct in that observation. I was reading a book on aviation medicine just yesterday and there was a clear reference to this type of contamination in the air from a variety of sources. The source was identified as oil bearing, as they call it, and they realised, for instance, that this oil bearing could release a large number of contaminants into the aircraft air under failure conditions. I have not been able to find all the details on it, but they make reference to what they call an 'air bearing' which seems to alleviate that particular problem of contamination from oil entering the bleed air of the engine which is used to pressurise the cabin.

Senator FORSHAW—This is a follow-up question, Professor, from the first question that was asked by Senator O'Brien. As you say, we are all individuals and people have different susceptibility, and some people have allergies and so on, therefore reactions may be different. But as a general rule, where you have the presence of toxic fumes or toxic chemicals in particularly a confined space, wouldn't it be reasonable that all people would be affected? I am thinking here of when people are affected by carbon monoxide. As I understand it, it can act fairly quickly and it will affect all people because of the dangerous toxicity of that product. I may be using the wrong words here. Therefore, where you have a situation where some individuals may be affected and other individuals may not be, can one conclude that, as a general rule, whilst it is not a suitable situation, it is not necessarily a dangerous situation either? Do I make myself clear?

Dr van Netten—I know what you are trying to say and I will gladly answer that component of it. What you are saying is: how come not everybody gets sick under the same conditions?

Senator FORSHAW—What I am saying is, where you have particular substances that are very dangerous and very toxic, what you end up with is a situation where everybody who is exposed invariably will get the symptoms and be sick. If it is something very serious like carbon monoxide in a motor vehicle, all of the people who may be exposed would be affected.

Dr van Netten—You are quite right. If the exposure is high enough, everybody gets affected by it. There is some anecdotal evidence from flight attendants, for instance, where all the passengers had to be woken up to get out of the aeroplane after the aeroplane had landed. There was an argument that was brought up before in some of your proceedings. I think Senator Crane mentioned that 'there are oil leaks, and there are oil leaks,' and, depending on the extent of the oil leak, you get different types of exposures.

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We should not forget that there is a specific self-evident truth here. The most sensitive people get sick first and they are your early warning signs of a potential problem. Often these people are looked upon as hypochondriacs or complainers or whatever else, and this is doing the system an injustice because it is actually quite dangerous to not pay attention to these people. They are really your early warning signs that something is wrong. The person next to you might get sick now because of a certain different physiology or background whereas you might get sick next, and this is the important component we have to worry about.

When you are talking about exposures which are close to being healthy or not affecting some people but affecting the next people, you always go through this sequence before everybody else gets sick. The first thing that happens is that the most sensitive person gets sick first. Then when the exposure increases and, of course, for longer periods of time, everybody gets sick eventually, and there is a whole gradient in between.

Senator FORSHAW—Thank you.

CHAIR—Thank you. That is helpful.

Senator CRANE—Doctor, my first question relates to the modification to the planes. I am sure you would have read in the evidence about the different stages and the different things that have been done here. Have there been any similar modifications made to the aircraft that you are aware of in Canada or that have been involved in any of the work that you have done?

Dr van Netten—I am not aware of similar actions in Canada. I have not been involved with AirBC to any great extent up to this moment in time, for a variety of reasons. I do know from AlliedSignal, which is now Honeywell I understand, that they modified the seals that used to give them their problems regarding the leakage incidents. Apparently the new seals are somewhat better than the old seals but incidents still occur, and I have some examples of that later on as well, but that is all I know that has happened within the Canadian scene.

Senator CRANE—Thank you. My next question relates to your letter—I guess we would call it—where you have made particular reference to the toxins and you have distinguished carbon monoxide. Can you give any indication to the committee, or do you have any knowledge or any information, as to what the crew or the passengers would react to first: excessive carbon monoxide or excessive smoking and the possible toxins in the air?

Dr van Netten—I do not quite get your question. Could you repeat the last part again, please.

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Senator CRANE—Sorry. What I am asking is: you made reference in your letter in the last two paragraphs with regard to the toxins released from the pyrolysed oils, with the temperature, and the impact of it. You also make reference to the fact that there are some levels of carbon monoxide involved and you made reference in your presentation to the carbon monoxide. What

I am trying to establish is: what is the likely reaction to either one in isolation from one another? Would people react to excessive levels of carbon monoxide more than the toxins or the smoky oil or whatever it might be, or would it be the other way around, or doesn't it really matter?

Dr van Netten—I understand the question you are trying to ask. You are quite right. Often what we tend to do is to identify one agent and look at the nasty effect of that particular agent. This has effects when you are talking about high exposures. When you talk about these intermediate exposures where some people get sick and other people do not get sick, then all the other factors become very important that might make a person more susceptible compared to another person, or a situation more susceptible than another. This means that you are not talking about just carbon monoxide perhaps in the environment but also many of the pyrolytic products that might come from the engine which we do not know much about. The combination of these things might precipitate a particular type of reaction which is hard to distinguish, and this is part of the problem.

It is not specifically carbon monoxide exposure—which people are always talking about—or a specific exposure to the tricresyl phosphates, it is a combination of these things. In addition to that you also have the condition of hypoxia where there is a lack of oxygen in the air. The three of them together as a collective group can cause problems which we do not know much about, because all we have done so far is investigate each individually but not as a cocktail of exposure, so to speak, and that is the important part that happens in an aircraft; we are exposed to a cocktail of things and agents which we really have not identified. I try to identify some of those components in my research, to at least identify some of the main important agents that you might be exposed to, so that we can either eliminate them or identify them as a serious problem.

Senator CRANE—What you are basically saying to us is that the research has not been done to establish the interrelationship between oxygen, carbon monoxide and the smoke or the toxins that might come into the cabin.

CHAIR—In combination.

Senator CRANE—In combination, yes.

Dr van Netten—You are quite right in that observation.

Senator CRANE—Thank you.

CHAIR—Thank you. Would you continue with your four points, Professor van Netten. It has been very helpful so far.

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Dr van Netten—The third question of carbon monoxide has come up already in this session as well as in many of the previous sessions. In addition to that, my statement that British Aerospace has been quoting has also apparently come up, where I make the statement that the air quality in a BAe146-200 is the same, if not better in certain conditions, than a Dash-8 aircraft. This is only under conditions where everything is functioning normally, and this is quite correct. The air in a normally operating, properly functioning aircraft is the same as in a Dash-8 and is quite a normal experience. There is nothing wrong with that, but they stop there. They do not mention, for instance, that I also make other conclusions which they do not always seem to be quoting me on. So I call it a case of selective quotation from my reports.

My other conclusions in these reports, for instance, state very clearly that there might be a potential hazard to the flight crew and the passengers due to the potential carbon monoxide exposure during an oil seal failure, and the recommendation is to use carbon monoxide monitoring to either identify carbon monoxide as a source or as a hazard or eliminate it as a hazard. If we do not make the measurements we do not know what we are up against, and to date I have not seen any clear-cut data that suggests that people have made measurements during an actual oil seal failure incident where they can say, 'Yes, there is carbon monoxide,' or, 'No, there is not a lot of carbon monoxide, which can do a certain amount of damage.' I make the conclusion that carbon monoxide monitoring is a very important component here.

In addition to that, I have also given warnings against the use of activated charcoal filters. Activated charcoal filters are very useful in cleaning the air, which is fine and great, but one of the things it does not filter out is carbon monoxide. It takes care of the smoke and the smell, and the smoke and smell apparently are very important. I think if you look at the statements by Captain Kolver, one of the pilots, he actually states that it is the smoke and smell that warn him of a particular problem and he uses smoke and smell as a way of identifying the source of the problem so that he can eliminate it by switching things off or on.

If you have an activated charcoal filter in the aircraft and you get rid of the smoke and the smell, and in addition you do not know what the carbon monoxide levels are, you have a potential problem because you do not have an early warning system. What I am saying here is that it is important that if you have a very efficient filtering system, which is great for the air, make sure you also have a good carbon monoxide monitor next to it to be able to tell you if there is a potential problem. The early warning signs are very important for the flight crew to be able to make the appropriate changes in the mechanical ventilation of the aircraft.

The next question you might very well ask at this time is: is carbon monoxide a problem? Is there any evidence? What do we know? What don't we know? First of all, you look at the symptoms that people have been reporting. Many of the reported symptoms are consistent with carbon monoxide exposures. For instance, the short-term exposure effects are headache, nausea, disorientation and a variety of other things that you, I am sure, have come across in many of your sessions. But in addition to that there are long-term effects as well, and people seem to be ignoring those.

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There can be Parkinson's-like syndromes associated with carbon monoxide exposure, and some of the people that you and I might have seen have symptoms that are very much like Parkinson's disease. These symptoms usually occur two to three weeks after the initial exposure has occurred and the initial recovery has taken place. These are long-term effects that affect people and they are very similar to what you might find with Parkinson's disease.

Another point that ought to be remembered is that oxygen administration appears to help to alleviate all the problems that people might be experiencing. With the Swedish incident we do not know if it was carbon monoxide or not, but the fact was that the pilots had enough sense and enough time to put the oxygen masks on and they luckily were high enough in the air to be able to recuperate because of the oxygen so that they could land the aircraft properly. That by itself steers us into the area that maybe carbon monoxide might be part of the problem that these people were experiencing.

Just recently I have obtained some reliable and interesting information regarding carbon monoxide during some of these aircraft incidents. For instance, if the aircraft takes off and there is an APU that is not functioning properly, you get a short peak, for instance, of carbon monoxide and the highest we have measured to date or people have measured for me to date is around 64 parts per million of carbon monoxide, and this was consistent with an APU that was found to be non-functioning two days later. What happens then, according to the pilots, is that you switch on the auxiliary power unit during take-off, you get in ascent for about four to five minutes and during this period of time you actually get a certain amount of carbon monoxide being released if the APU engine is not functioning properly. So we do have some data now that shows there is carbon monoxide released.

That is consistent with what I found in the laboratory. We found in the laboratory that, when you heat these oils to a high temperature, 500 degrees Celsius, you get a release of carbon monoxide, amongst other things. What happens in a laboratory is not always what happens in an aircraft, but it can give you an idea of what to look for, and that is now confirmed by some of the evidence that we have found in actual real-life conditions, that when you have a failure within the aircraft, you do get carbon monoxide being released.

It is interesting to note that the aircraft which had the 64 parts per million of carbon monoxide releasing into the air had smoke in the cabin two days later, or a serious incidence from that same APU, so it will be interesting to whether, if you were to monitor carbon monoxide properly in these aircraft, you might in fact have an early warning system of a future leakage of the APU that might have an oil seal failure. Consequently, we need more data to be able to see if this is a useful tool to identify an oil seal failure before it actually happens and allows smoke to enter the cabin. Are there any questions on this section so far?

CHAIR—I think that is very clear. Would you continue. We will be up against time shortly, so we want to get as much of your evidence on the record as possible.

Dr van Netten—I will continue. My last point is: are these carbon monoxide levels high enough to account for the symptoms that people have experienced? We have discussed that briefly before with one of the senators. I will just reiterate it and try to fill in the gaps, so to speak. We know, for instance, with what I have measured or what has been measured in an aircraft under similar conditions, that we measured 64 parts per million for four minutes and that by itself is not a particularly significant exposure. The exposure limits are based on eight hours at 25 parts per million and this is a very short period of time, so by itself that cannot tell us a lot.

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Mind you, we do not have a lot of experiments that show what is happening within the aircraft. All I have is the data on two aircraft. What we need now is data on aircraft that have a serious oil seal failure, to see what the carbon monoxide levels are under those conditions. We need, therefore, reliable measurements during incidents that relate to smoke in the cabin. To date I have not seen these measurements. If an engine oil seal failure is the source of the problem, one would actually expect the reverse sequence of carbon monoxide exposure during flight than what I observed when there is an APU that is non-functioning.

With an APU you find that you get a short peak while the APU is in operation. If the APU is working properly and the engine is at fault, you find that the carbon monoxide in the air during the APU operation is at background level, but then when the engines kick in to start pressurising the cabin you will find that the engines should be releasing a fair amount of carbon monoxide if there is an oil seal failure. Consequently, you get sustained levels of carbon monoxide over a long period of time. This is again hypothesis at this moment because we have not measured those things in a real-life situation, but this is the type of thing that needs to be addressed to be able to come up with some answers.

In addition to the symptoms that people have been describing regarding their experiences after being part of one of those incidents, many of the textbooks deal with carbon monoxide by itself. They deal with tricresyl phosphates. Even if you were to look at carbon monoxide exposures by themselves, they are all based on ground level experiments at normal altitude. When you go up in the air, we do not really know how this affects the toxicity of all these compounds. These are things that we really do not know much about and, again, they have to be addressed.

As I said before, several agents can exacerbate hypoxia, meaning a lack of oxygen in the air, such as ethanol and antihistamine preparations. This has been well known and we can give the references for those. We also know that exercise leads to hypoxia sooner than in individuals at rest. This is very important for flight attendants, for instance. I read some early articles from the 1930s where they were addressing what is a safe level for people to be exposed to in an aircraft while they are on a transatlantic flight. It was very interesting. The person who did these experiments states the following:

> If acclimatized airman remains at rest or seated while in flight at altitudes as high as 10000 to 12000 ft there is little objective evidence of any impairment. If one engages in overt physical activity, as may be observed in a steward while actively engaged in serving meals at 10000 to 120000 full-time—

of altitude—

> the pulse rate may be considerably increased, slight cyanosis—

blueing of the face, et cetera—

> and fatigue may be observed, as well as heightened temperamental reactions.

This might explain some of the behaviours that we might have observed in the past. I would also like to mention in addition to this that, based on these experiments and other experiments, the safe altitude they suggested was around 6,000 feet altitude or the equivalent of 6,000 feet.

As I said before, also one is not exposed to carbon monoxide alone but to a cocktail of pyrolised and original oil components. These combinations of exposures have not been studied and it would be wise to pay close attention, as this committee is presently doing, to the complaints and symptoms experienced by flight crew members. I would like to keep these things in mind to be able to come to a proper conclusion. Are there any questions about my last point?

CHAIR—Yes, there is a question from Senator Crane.

Senator CRANE—My question relates to the difference between the hydraulic oil from the APU vis-a-vis the oils from the engine. Have you done any experimental work independent of one another to see whether or not there is a major difference in the constituents that are released from the pyrolisation of the oil and the heating of it?

Dr van Netten—The oils in the APU are identical to the oils used in the engines. In other words, there is no difference in their constituents. Usually an aircraft company will stick to one type of oil. AirBC, for instance, was looking at Castrol and Exxon at one particular time and they used the same oils in the APU as well as the main engine. That makes it very convenient for the operator to stick to one type of oil.

Senator CRANE—Thank you. I had not realised that.

CHAIR—Thank you, Professor van Netten. Your evidence is very valuable indeed and we may even be in touch again. We are very grateful to you for giving us this time and the benefit of your knowledge. I am sure it is going to help our committee as we come to some kind of final conclusion. I will say good morning and thank you very much. Good morning here—I think it is goodnight there.

Dr van Netten—Good afternoon here. Thank you very much for an opportunity to be able to express some of my concerns. I have many more small points that could be made in due time. We can do that at a later time if necessary. Thank you again and good morning to you in Australia.

Committee adjourned at 8.48 a.m.