London Assembly Environment Committee – 27 June 2019

Transcript of Item 6 – Tube Dust

Caroline Russell AM (Chair): This now brings us to today's main item for discussion on the impact of Tube dust to Londoners. Can I welcome today's guests? We have Peter McNaught, the Director of Asset Operations at Transport for London (TfL). We have Rikard Moen. He is the Head of Occupational Health at TfL. Professor Jenny Mindell from the Department of Epidemiology and Public Health and University College London (UCL). Cat Cray from the National Union of Rail, Maritime and Transport Workers (RMT), Stations, Health and Safety Council Member. Welcome to everybody.

Tube dust; it started gaining attention back in the 1990s with people beginning to get a bit worried about the impact on the health of people working in the Underground and on people travelling on the Underground. I believe in 2003 the Environment Committee - long before my time, though within Tony's [Arbour AM] living memory of this Committee – looked at Tube dust, trying to get an understanding of its characteristics and its health impacts. More recently, it has come up both in 2017 and also earlier this year [2019] as part of larger inquiries about air pollution in London. We really felt it was time to give it its own session so that we could look into it properly.

As an opening question to all of you - and I will start with Peter and move through - what is your sense of urgency with the issue of Tube dust, and is this reaching a point where it may become unsafe?

Peter McNaught (Director of Asset Operations, TfL): First of all, thank you, Chair. I think it is important you say that TfL takes the issue of Tube dust very seriously. Since the Mayor got into power in 2016 and asked us to really take air quality seriously on the Underground, we enhanced our cleaning regime immediately. We commissioned the Committee on the Medical Effects of Air Pollutants (COMEAP) report. You mentioned the report that came out in 2019. It was us who commissioned that report because we wanted to understand if the views of COMEAP had indeed changed with advances in the understanding of particulate matter 2.5 (PM2.5). We commissioned that report. We enhanced our cleaning regime. We brought together a working group across London Underground of occupational health professionals, trade union representatives, our engineering community, our maintenance community and our renewals community to look at how we could target three main areas of targeting Tube dust.

First of all was how we stop or prevent the dust at source, then there was how we would enhance our cleaning and removal of dust, and the third area was any further research that we would do to try and understand the impacts of Tube dust.

On the stopping and preventing of dust, we obviously looked at the various things that create dust, from the wheel-rail interface, the brake blocks on the train, the carbon brushes on the train, fabrics from our customers, the engineering work that we carry out. We looked at how we can take action to reduce the dust created from those areas.

Then, on our cleaning regime, as I said, in 2016 we enhanced it, but we have since then been doing various trials to try to look at how can we make our cleaning regime even more robust.

Then we have commissioned further research into the toxicity of dust, epidemiology studies and sickness studies of our employees, who obviously are exposed to the dust for longer than normally a passenger would be.

Rikard Moen (Head of Occupational Health, TfL): From a health perspective, to answer your question, is there an urgent and imminent concern for the public or the employees, the answer to that is no. I am sure we will get into the details behind that. At TfL we have a large occupational health department purely dedicated to looking after the health of the employees. That is effect of health on work, and exposures at work on health.

On average, an operator or somebody who works down in the Underground would have 15 to 20 consultations over their career. They are more likely to be seen at occupational health than they would be seen by their own general practitioner (GP). I will go later into the actual things that we do for those employees, but part of that is screening and making sure that there are no health effects, not just from dust but mental, from noise, anything they might be exposed to. This has been going strong since the mid-1970s. We have the largest in-house occupational health department in the United Kingdom (UK), and that means that we know that if there were rising issues within our workforce, either short-term or long-term health issues, we would be seeing that coming through occupational health. I can categorically say that we have not been seeing that.

If we are comfortable with the health of our employees who are exposed to dust for longer periods, then the passengers, we can safely assume - if you look at simulated journeys on dust exposure, and again we can maybe touch upon that later - that is at a lower level to somebody who is working. From a health perspective, there is no imminent health risk, and there has not been, but we are continuing to review that and we continually review our data to check that we are confident with that.

Caroline Russell AM (Chair): Do you think it is changing over time? Do you think there is more dust now than there was?

Rikard Moen (Head of Occupational Health, TfL): I think the levels are fairly steady, interestingly. Peter will go into the cleaning regimes. We are trying to reduce them across the network, but there is certainly no increase in dust. There is no increase in dose-response.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): COMEAP are the experts. As a public health doctor, I know a little bit about a lot of things. Reading the report, the four things that struck me are first that the health effects of air pollution are primarily on the very young, the very old, and those with pre-existing circulatory or respiratory disease. Even if the levels were of concern, the susceptibility of the people exposed is going to be much less because, in general, people who are working are healthier than those who are not working, and the working-age population is healthier. If there were a problem, there would be less health effects than if it were the whole range of the population exposed.

One comment about some of the modelling is I was trying to think how many commuters would be underground for an hour in their journey, other than when things occasionally get stuck. Unless you are talking about two half-hour journeys because of commuting each way, I thought that might be a slight over-estimate. I would be interested to hear a bit more about Hampstead [Underground Station] because it is atypical; it is the deepest station. If you want to measure what the levels and the composition of the chemicals in the particles are that are almost exclusively because of or due to or within the Tube system, it is the ideal place, but it may not be typical in that the nearer you are to Overground areas and less-deep stations, there is going to be more of a mixture of the polluted ambient combustion product, so it is going to be a bit different.

My final point is that at a conference in London last autumn [2018] about physical activity, even in Beijing, where their ambient air pollution is horrendous, some modelling work shows that there are a handful of days a year where the adverse health effects of air pollution were worse than the benefits of physical activity. We need to keep this in perspective. Obviously, staff are exposed for much longer and that I think would be more of a concern, but, from what I know, I do not think it is unsafe. It is urgent in the sense of, "If you can do things about it, get on with it", but not as an emergency thing.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): Literally, dovetailing off what you have just said - I am the only member of station staff sat at this table and I have worked for the Tube for over a decade - the Institute of Occupational Medicine (IOM) report was in 2003. That was 16 years ago, and that recommended that TfL and the trade unions find practical ways of keeping dust levels low. I am really encouraged to see that focus and attention paid to our cleaning regime from 2016, but I am concerned that we are being reactive. We have not had an IOM report since 2003, we now have the COMEAP report since the beginning of this year, but it should not have taken 16 years - or 13 if you go the cleaning regime being increased - to be really looking at this. If we are always on the back foot, we are not improving it. If you are a transport worker, you spend more than an hour in this environment.

It is important that we talk about commuters and passengers too, but particularly about that platform-train interface (PTI) area. If you travelled on the Tube here today and you saw a member of staff holding a baton in the air and making public announcements (PAs), they are not just there to make PAs. They are there to monitor that PTI because it is an area of the station environment where the most serious accidents and the most serious injuries can happen. We want staff there, but obviously they are exposed for a longer amount of time than a passenger would be.

Since the IOM report there has been a huge increase in the number of passengers that we have, so we have more passengers. We have more differentiation in rolling stock. That is a very boring word that means different types of trains. You get on a Jubilee line train, it looks different to a Piccadilly line train, it looks different to a Metropolitan line train, but all of these things - I am sure we will get into it in the iron content and the metallic elements in the air quality, because it is big, heavy trains on big, metal wheels on big, metal rails. That is going to affect what type of air we are breathing in. We do have to consider all of these changes.

Yes, I do think there is a danger, and I think we need to be careful saying, "Don't worry, you're fine". If we had a report from 2003 saying, "You need to do something", and in 2019 TfL has quite rightly said, "We accept the findings in the COMEAP report", we do need to not stand by and say, "Everything is OK" and focus too much on making ourselves look good. What can we do that is not just reactive but looking ahead 10 years, 20 years, 30 years?

Shaun Bailey AM: Just to go back to the comments that the Professor made about the methodology behind this study, we talked about going in the deepest station, we talked about the ride-time that people are doing on the trains and we talked about how long staff are exposed, but are we confident that this report has looked at the right things and has chosen the right station? Cat talked about the length of time for when the report was written. There are significantly more people now using the Tube. I could tell you of a number of people who ride the Tube for more than probably half an hour each way, just because people commute from so much further out.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): I have a journey that is that long. It is just that half the journey is above ground, so you are exposed to the same or possibly less pollution as you would be if you were sitting in a car.

The COMEAP report; these are the experts on air pollution and its health effects, and the 'M' is for medical effects. They were looking at the studies that they could find, and Mark Nieuwenhuijsen - who also used to be at Imperial College and is now at IS Global in Barcelona - did the literature review. I am sure that that was done properly. One of the issues is that there are relatively few studies that have been done. TfL may well have done their own measurements at different places. In fact, from what I understand about the studies you are doing about how long it takes dust to come back and what the different ways of cleaning do, you must be measuring those things.

I was just commenting that if you want to know what the composition is of the particles and the size and the number of the particles that are Tube-related rather than coming in from outside, then Hampstead is the ideal station, but I would imagine and as I say, I am not an expert - that some of the Underground stations have levels that are more in-between Hampstead and ambient air and have composition that is more in-between.

Shaun Bailey AM: That is my point. How accurate are the measurements? Cat made the comment about different types of train. If one train is significantly heavier than another, the station might be in a better place from a depth point of view and how much of that line is above ground, but if the train is putting out significantly more because it is a heavier type of train or using different disc brake materials, how widespread and how accurate are these tests?

Rikard Moen (Head of Occupational Health, TfL): On a regular basis across the whole network, we do monitoring. There are two types of monitoring. One is personal monitoring, where we put a monitor on the driver or the station staff and measure what they are specifically exposed to, and then you have static monitoring where you have it just sat there at all times. As we go forward, I can share that data with you. That data is very reassuring. It is well within HSE (Health and Safety Executive) limits.

Just very quickly, the HSE limit is what we call an OEL (Occupational Exposure Limit), and that is at the level where there is no risk to health. If there is a concern about a hazard, whatever hazard that may be - think of asbestos or noise - then it is an MEL (Maximum Exposure Limit). All of the metals and substances that we are detecting, none of them have an MEL. I can go into that in greater depth after.

Caroline Russell AM (Chair): We will be coming on to more of that in future. I think, Shaun, this should be picking up on the original question, which is the sense of urgency about the issue.

Shaun Bailey AM: I am just focused on: are we happy about the monitoring and the methodology behind the testing that we are doing? We are happy. Is that what we are saying?

Rikard Moen (Head of Occupational Health, TfL): Yes.

Shaun Bailey AM: Fine.

Rikard Moen (Head of Occupational Health, TfL): We know across the network, every platform, we know which Tube line is worse. Again, I can share that data with you. We know which platforms are worse.

Caroline Russell AM (Chair): Shaun, you are straying into future questions, so if you want to come in, you can come in on the question that we are on.

Shaun Bailey AM: Chair, I just wanted to understand that.

Caroline Russell AM (Chair): I just want to pick back up on where Cat left us, because Cat mentioned that it has been a long time since the 2003 report. It is very reassuring that TfL have been doing so much on this since 2016, but why has this only been addressed in the past few years when we know that there has been concern about the issue? This is really a question for Peter and Rikard.

Peter McNaught (Director of Asset Operations, TfL): I think the Mayor's request focused us in on it again. I do not think nothing has been done since 2003. Some of the things I can take you through are long-term actions that were thought of several years ago around moving to rheostatic braking in trains, which takes away a lot of the wear on the brake locks. Moving to alternating current (AC) drive technology takes away carbon brushes on direct current (DC) motors. These are things that were thought of long before 2016. Also, some of the work in our renewals area around concrete bursting instead of concrete breaking were put in before 2016. It is really just the Mayor focusing in, saying, "We need double the effort on this" that has brought us back to looking at the whole picture and everything we can do. I think it has been worked on, but it is now being worked on a lot more.

Caroline Russell AM (Chair): With more urgency.

Rikard Moen (Head of Occupational Health, TfL): It was not reactive. It was actually a proactive report. I agree, it is quite a few years since the last one, but the key finding from the IOM report in 2003 is:

> *"However, we do not think that the risks such as they are warrant any special or extraordinary measure to limit exposure either of the workforce or the travelling public."*

That is very reassuring. That does mean you should not look at that again. As Pete says, certainly within the health function, we have been doing that since the 1970s, irrespective of all of this. As Pete says, that work has been ongoing. I think we just felt it was the right time to have another look, and that was really the purpose of the COMEAP: can we still rely on the IOM findings or do we need to reconsider what we are doing? That was the drive behind it.

Caroline Russell AM (Chair): Peter, you said that there were epidemiological reports from TfL on Tube dust. Are these accessible to the public? The monitoring reports do not include epidemiological analysis.

Peter McNaught (Director of Asset Operations, TfL): The epidemiological study was one of the things that came from the COMEAP report. It was one of the research recommendations that COMEAP asked us to look at in the beginning of this year. We are in the process of commissioning that with King's College now. They are working up the scope of it with a view to doing that, using our pension records. It will take some time because we are going to look at employees over the last 50 years to understand impacts on cardiovascular ailments that may have caused people to die after they have left London Underground.

We have also commissioned a report with King's College and Imperial College to look at sickness of our employees, which we will get the results on much sooner, I think within the next three to six months.

Caroline Russell AM (Chair): Will those be made public when you get them?

Peter McNaught (Director of Asset Operations, TfL): Yes.

Rikard Moen (Head of Occupational Health, TfL): Yes.

Caroline Russell AM (Chair): If you could send those specifically to this Committee, we would be very grateful.

Rikard Moen (Head of Occupational Health, TfL): To just answer your question, we actually have not done full-blown epidemiology studies, because it is expensive to do, but we are following the COMEAP report. King's College and Queen's College are doing ongoing research on the dust, and any research that is done gets published. Whether it is good, bad or indifferent, it will get published.

We have done our own work internally and I am relatively comfortable with what we have, but you want there to be an independent, outside, academic body like COMEAP to say good, bad or whatever, and that will always be published. We have no influence, even if the results are bad, to say, "We don't want that to go out". That will all be published.

Caroline Russell AM (Chair): OK, great.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): Can I just make a very brief point? As you said, the IOM report said there was no substantive harm, but the COMEAP report said that we cannot rule that out. That is significant. If you go to the statement, paragraph 3 of the COMEAP report, or if you go to the end of paragraph 3, page 2, it says, "There is insufficient evidence to provide quantitative comment". Going back to your point, what it is saying is we need more studies. We need more consistent measurements.

I do contest what Peter [McNaught] said about monitoring on station staff in particular. That has not been done enough and there is some disagreement about that, because the mobile monitoring is much better than static. Also, we are not monitoring and measuring the effects on our station cleaners, who could possibly be spending more time in a platform area than a member of London Underground staff, except that they, on a technicality, have a different employer. Any member of staff who works on the London Underground who could be exposed needs to be considered, and we must not rule cleaners out.

Caroline Russell AM (Chair): It did not occur to me that cleaners would be left out but thank you for raising that.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): Me neither.

Leonie Cooper AM (Deputy Chair): It was just really to try to understand why there was reporting in 2003 and then there was this huge gap to 2016. What action was taken? You have said, "It is not that we were doing nothing". That is 13 years. What were the first Mayor and the second Mayor doing during that period of time? I know a number of people are now saying it is dangerous and it is really high, and obviously we are saying that we need more information. I just wondered if TfL could explain what action was taken during that period of time.

Also, I wondered if Cat from the RMT could just explain. Were the RMT raising concerns? That might be something where you need to write to us and say, "Here is a set of letters that we wrote during that period of time, asking for this to be looked at" from the RMT's side. I am just wondering because that is such a long period of time. 2003 was the first term of the [London] Assembly. The Environment Committee was at that time being chaired by Samantha Heath, my close friend and colleague, who has recently died. Another ground-breaking piece of work that she was doing there. It is such a long time. Thirteen years. Why so long?

Peter McNaught (Director of Asset Operations, TfL): As I said earlier, I do not believe people were doing nothing. I think people have always been looking to enhance the cleaning regime, possibly not with air quality in mind at that time. It was probably more with regard to doing it more efficiently with regard to cleanliness and prevention of fire, rather than considering air quality and PM2.5. Certainly the consideration was there in the renewal of assets, the design of assets, to try to reduce that production of dust from wheel-rail interface, from brake locks, from brushes on motors. It was not that we were doing nothing. It just was not the focus that we have put on it since the period of --

Leonie Cooper AM (Deputy Chair): No, I am not saying you were doing nothing. I am saying that you just said that things were being done, but it seems like a long time in between big reports. Could you set out for us what was being done? You have said cleaning and all the rest of it, but was there analysis being done of the impact at all, or you were just deciding that we needed to do this? You have mentioned fire. Obviously with the aftermath of the King's Cross [tube station] fire there were huge changes made to the entire Underground system, but I am still not getting a very clear picture of how things might have been moving forward at all.

Peter McNaught (Director of Asset Operations, TfL): As I say, we were moving forward in the design and renewal of assets. The assets we were replacing. Also, as I mentioned, in our renewals area we identified that the work that we were doing when we were breaking out old rail and replacing it, the methods we were using were creating quite a lot of silicates and putting silicate dust into the Underground, so we moved to different methods to reduce that. We have since - I am now talking since 2016 - started to seal off the areas where we work to isolate them from the rest of the Underground and then clean them before we re-open them up. We have done the same around grinding --

Leonie Cooper AM (Deputy Chair): I understand that, and I do know about that, and I think it is a really good thing. Obviously, construction dust is another plague in London because we seem to be rebuilding the city all the time. It is the period between 2003 and 2016. I do not know whether there is anything you want to add to that, Rikard, at all?

Rikard Moen (Head of Occupational Health, TfL): There are two bits to that. As I say, we have been doing most of it since the 1970s, certainly on the health side. On the monitoring side, we are monitoring levels. That is ongoing irrespective of any report. That is something that is ongoing. If there is no change either in your exposure levels or duration of exposure, then there is no increased risk behind that, so there is no catalyst to suddenly say, "Oh my goodness, we need to do a report". There was nothing flagged that anything had changed. If anything, the breakdown of the dust had improved from previously, but the actual levels of dust, level of exposure and duration of exposure was the same. There was no increased risk, so there was nothing that said, "We have a problem here. Let's have another look". That is why I am saying it was proactive, rather than reactive.

Could we perhaps have done it sooner? In hindsight it is easy to say, but there was nothing flagging up that we have a problem, and certainly not in the health department. Was there anything flagging up --

Leonie Cooper AM (Deputy Chair): You do not think there is any criticism due to the previous Mayors for failing to act, and on the other hand there would be no criticism of the current Mayor for starting to look into this? He has obviously been doing it since 2016 when he first came in. Would that be fair?

Peter McNaught (Director of Asset Operations, TfL): I think there was probably a good period of time after 2003 where the IOM report was seen as saying that the risk to the travelling public and employees was not there. It was actually us commissioning the COMEAP report to say, "Can you reconsider this recommendation you gave us?" where now they have come back and said, "We do not have sufficient evidence

to say either way". I think there was possibly a period of time where people were cleaning in the Underground purely for the prevention of fire and tidiness and not for air quality. This Mayor has come in and said, "Air quality. You need to get it sorted". That has changed the focus.

Leonie Cooper AM (Deputy Chair): Yes. In 2015 he wore an air quality monitoring device, started in Putney High Street with me and then went into the Tube wearing it, and I know what the outcome of him wearing that was. That was before he was elected. In September 2015 he became very aware of this.

I just wondered, is this something that the RMT was raising during that period?

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): I am happy to give a formal response in writing but I can give you a brief response here.

Leonie Cooper AM (Deputy Chair): Yes, thank you.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): The answer is yes, since the early 1990s in different guises, and we were not the only union doing that. The fact that there is now an Air Quality Committee is, in my union's view, due to the trade unions pushing for that to happen. That was discussed under our health and safety forum and we pushed for it to have a separate meeting, and I joined that committee at the beginning of this year. Whether they are happy about that or not is another matter.

Peter McNaught (Director of Asset Operations, TfL): No, we are very happy.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): Yes, so we have been, and there is more --

Leonie Cooper AM (Deputy Chair): Smart fishing for a compliment there.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): Of course, there is more we can be doing as trade unions. When nothing is flagged up that anything has changed, we have to look at corporate responsibility. What ethical model do we have if we are waiting for something to flag up? That is wrong. That is not the right way to go about it. We also need to have a discussion about legislation and whether those levels are actually safe, whether the legislation is fit for purpose as well.

Leonie Cooper AM (Deputy Chair): This is just my final question. Are you pleased that the Mayor started to take action from 2016 as soon as he was elected?

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): Of course I am. I am happy to see any political person in a position of power make ethical decisions and say, "I want hard science" and say, "We need to look at how this is affecting people". Long-term exposure is difficult to measure because it takes a long time, but I work with members of staff who say their eyes are scratchy more often, they cough a bit more, they seem to get a cold a bit more. If they are asthmatic, they get asthma attacks a bit more often. These little things, which will not necessarily mean you take time off work, are all incremental. They all add up.

I get to sit in these meetings and hear some of the genuinely innovative things that you are doing, but I also go back to workplaces and hear people talk about their experience and feel that they do not feel duty of care is being shown to them.

Leonie Cooper AM (Deputy Chair): I would like to see the correspondence that the RMT was entering into between 2003 and 2016 and trying to push it forward. It is great that the current Mayor has taken it on. It is a shame the previous Mayors did not perhaps do so.

Caroline Russell AM (Chair): David, can I bring you in to look specifically at the composition and concentration levels of Tube dust?

David Kurten AM: Thanks. Yes. My questions are mainly to you in TfL on how you measure and monitor Tube dust levels and their composition and concentration. How do you currently do that? Rikard, you mentioned that you have ongoing data over a number of years. I assume that you had a programme in place to monitor Tube dust levels. How often do you do it, where do you do it, and who does it for you?

Rikard Moen (Head of Occupational Health, TfL): I know we do it everywhere. We actually have an industrial hygiene department who specifically focuses on that. We do Hammersmith [Station] six times a year, but we will certainly have covered the whole network. We have an established regime that we bring somebody in to do that measuring, both personal and static. I would have to get back to you if you want to know specifically how often we do it.

David Kurten AM: We have mentioned Hampstead before, which, as Professor Mindell mentioned, is the lowest station, so you have some data from Hampstead. My concern is that you do measure it everywhere. Do you measure the levels in all the different stations?

Rikard Moen (Head of Occupational Health, TfL): Yes.

David Kurten AM: You do. Do you publish those data?

Rikard Moen (Head of Occupational Health, TfL): Yes.

David Kurten AM: You do. You do that regularly, many times a year?

Rikard Moen (Head of Occupational Health, TfL): Yes.

David Kurten AM: Sorry, Cat, you mentioned the edge of the platform where the trains go.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): The PTI, yes.

David Kurten AM: When you do, which is a specific area of concern. When you measure the levels in the stations, do you measure different parts of the stations? Do you measure the edge of the platform? Do you measure inside, where people are walking up the escalators, or is it just normally one place in the station?

Peter McNaught (Director of Asset Operations, TfL): We have done in the past, but the reason we put the static sampling at the platform edge is because historically our measurements have shown that that is where the highest concentrations of particulates and are where a customer might be standing. Obviously, deeper in the tunnel, particulate levels might be higher outside of the train, but we do do simulated passenger runs where we measure in the saloon, and obviously the ventilation system of the train reduces the particulates before it comes in. The static monitoring is done very deliberately at the platform edge because that is the highest area of concentration.

David Kurten AM: That is good. That is very good that you do it.

Rikard Moen (Head of Occupational Health, TfL): Also some lines, like District and Circle, have virtually next to no exposure at all, whereas the Bakerloo line is the worst. A bit like Hammersmith is the worst station, you very much want to focus on your highest-risk areas. That is the best way to spend. There is a risk-based approach as well, which is important.

David Kurten AM: Yes. I have heard that you use consultants, 4-RAIL. Is that true?

Rikard Moen (Head of Occupational Health, TfL): Yes.

David Kurten AM: How often do you use them to do the monitoring? Can you talk about your relationship with them?

Peter McNaught (Director of Asset Operations, TfL): About once a year. It is not quite once a year but it is around every 18 months on average we bring them in to carry out a study for us on measuring that, yes.

David Kurten AM: That is a wider study. What is the purpose of doing that, rather than your ongoing measurements?

Peter McNaught (Director of Asset Operations, TfL): Just purely the sampling that we do. We produce the report. We share the report at the Air Quality Working Group. We look at hotspots, any changes, so we can see what impact we are having.

David Kurten AM: Is the ongoing measurement done in-house and then you bring in 4-RAIL to do an overview every 18 months? Is that how it works?

Peter McNaught (Director of Asset Operations, TfL): In-house tends to be any particular studies we might be doing, extra things we want to do. 4-RAIL tends to do a consistent report once every 18 months to give us some control and gauge on what is happening.

Rikard Moen (Head of Occupational Health, TfL): The industrial hygienist - Jenny brings in consultants to do this as well - will target specific areas, whereas the 4-RAIL report is the definitive, whole-network report. There is ongoing work in between.

David Kurten AM: There is ongoing work, which is in-house, and then 4-RAIL come in at certain periods and produces an overall report.

Rikard Moen (Head of Occupational Health, TfL): Yes.

David Kurten AM: I am just trying to understand how you do it and who you use. Is there any possibility of getting live data on the particulate matter levels, or is it something that you could only do at certain periods throughout the year?

Peter McNaught (Director of Asset Operations, TfL): When you say "live", the closest we've had is King's College at Waterloo put a constant sampling over a period of time so we could see it at that station through the day at the different hours of the day to see the impact, and it did show the impact, but obviously

the movement of trains has a massive impact on the particulate level. At night, when there are no trains running, it is some of the cleanest air in London. It is the movement of the trains that stirs up the particulates.

David Kurten AM: OK, that is interesting. Do you have something to say on that?

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): A couple of things. My knowledge of measurement of air pollution is now about 15 years out of date. When I was doing my PhD, which was about quantifying the health impacts in Kensington, Chelsea and Westminster, the measuring tools that might enable you to do that were incredibly expensive, and the ones that were easier to afford to use more widespread, were based on capturing particulates on a filter, which was then weighed. No, you cannot do that in real time. As I say, I am out of date from that.

A couple of points I wanted to make related to this. One is that obviously this COMEAP report focuses on PM2.5, and I think we should remember that at the turn of the millennium PM2.5 was really only just beginning to be measurable, let alone starting the epidemiological studies. When I was doing my PhD, it was very much focusing on PM10, and a lot of the studies I was reviewing were looking at bigger particles which probably do not get into your lungs anyway, in their studies. It is not unreasonable that PM2.5 was not being monitored and assessed early on because nobody was doing that.

The other thing you were mentioning about composition. Again I am out of date, but it used to be that composition was something that would have to be done as a special study and there would not be a routine measurement, and I think that is probably why there is much less information about that.

Rikard Moen (Head of Occupational Health, TfL): You could probably go live on total dust levels. You could probably have a live-streaming number of your total dust levels, a bit like pollen. The actual breakdown, no, that has to go to gas chromatography and be broken down where all the individual metals are.

David Kurten AM: You were mentioning about some study that King's College did in Waterloo. Was that total dust levels?

Peter McNaught (Director of Asset Operations, TfL): That was just total dust levels. It showed me the PM level. It did not show me the breakdown. It just showed us the level of particulates in the air over time.

David Kurten AM: That was not PM2.5s? The PM2.5 levels might still be high even if the total dust levels would be varying at a much greater level.

Peter McNaught (Director of Asset Operations, TfL): I am not sure if it was PM2.5, PM4.3 or --

Rikard Moen (Head of Occupational Health, TfL): It was actually PM2.5. The PMs is just the size of the --

David Kurten AM: Yes, I have got that.

Rikard Moen (Head of Occupational Health, TfL): It encompasses everything that is 2.5 or below, so the total amount -- I suppose you do have total respirable dust. You probably have what we call nuisance dust.

David Kurten AM: Is that 4.3? That is the --

Rikard Moen (Head of Occupational Health, TfL): Yes, but by 2.5 you capture everything that you want to look at.

David Kurten AM: The study in Waterloo was PM2.5, was it?

Rikard Moen (Head of Occupational Health, TfL): Yes.

David Kurten AM: OK, so it is possible to do that. When was that study? Professor Mindell talked about 15 years ago, but was that study more recent?

Peter McNaught (Director of Asset Operations, TfL): Yes, it was last year [2018].

David Kurten AM: It is now possible that you can do that and measure it in live time.

Peter McNaught (Director of Asset Operations, TfL): But not the chemical breakdown. The PM terms confuse me. I like to think of it as a shovelful of gravel with medium-sized stones, small stones and sand, and I put them through a PM10 sieve and everything falls through that is PM10. PM4.3, the medium-sized stones, get stuck, and the small stones and the sand fall through, and PM2.5, the small stones, get stuck and you just have the sand at the bottom. They are the fine particles that can get right into your lungs, to your alveoli.

David Kurten AM: We are told that the PM2.5s are the most hazardous to health because they can get deep into the alveoli.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): It is worth pointing out that the legislation does not require you to measure that, PM4 and above.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): Yesterday I found a diagram from the American Environmental Protection Agency, which has not yet been closed down, just showing about the size of these things that we are talking about that might be --

Rikard Moen (Head of Occupational Health, TfL): The most dangerous thing to health - and this is really where it is important because this is where ambient air in the Underground is very different, and this is really important - is the size of the particles. The average size of particles in ambient air is 0.2 milligrams per cubic metre. The average size of the particle in the London Underground is 20 times the size of that.

David Kurten AM: Sorry, 0.2 milligrams --

Rikard Moen (Head of Occupational Health, TfL): 0.02 milligrams per --

David Kurten AM: That is the concentration level, not a size, isn't it?

Rikard Moen (Head of Occupational Health, TfL): Correct, and that is how PM2.5 is measured. Now, there are two ways you can measure. It is either total particulate or the weight that you collect in that sample. The elements in the Underground are much heavier, which is why the PM2.5 is 50 times higher than the ambient air. It is not 50 times the risk. It just means that the bit that is measured in the Underground is 50 times heavier than the bit that is measured in the ambient air. If you were to do total number of particulates, it would be the other way around. The ambient air would have 50 times as many pieces as you would have in the Underground.

You hit a very important point. The danger to health is the smaller the particle. Ultrafine particles, which are less than 1 micron, are where the health effects tend to occur, because they can get right into the bottom of your lungs and, more concerningly, can then cross your lung-blood barrier into your bloodstream.

David Kurten AM: Now you are mentioning PM 1 micron, which would be, in that terminology, PM1.0, and no one has ever spoken about that before. People are always talking about PM2.5s and the Mayor has a target for PM2.5s. There is going to be a legal limit of 25 micrograms per cubic metre of PM2.5s coming in in 2020. All the discussion has been about PM2.5s, but now you are saying that is not really that important and it is PM1s that are the most dangerous and hazardous to health.

Rikard Moen (Head of Occupational Health, TfL): There are different constituents. You have your volatile organic compounds and your carbons, which are bigger. To capture everything, the larger the sieve, the more you catch, so you have to set that somewhere. You could potentially measure both, to look at both, but at 2.5 you know you capture everything. It is really just to put into context that the size of the particle is not always automatic. Diesel, for example, is in the hydrocarbon --

David Kurten AM: It would of course give a range of different sizes of particles, so then we get some which are 10 microns, 8 microns, 4 microns, 1 micron. I understand PM2.5s are everything that is less than 2.5 microns, which you say you have measured that in Waterloo, so it is possible to measure those things on a continuous basis, which I think is very, very helpful to the public to be able to see that, and then they could look at something and say, "Oh, this is what the PM2.5 levels are. The Mayor is telling us this is dangerous. The Government is telling us this is dangerous. Everyone is saying this is dangerous". People need to know the levels of PM2.5s. You seem to be sowing a little bit of doubt in saying that now.

Rikard Moen (Head of Occupational Health, TfL): No. This is the difference between hazard and risk. The PM does not indicate risk. It just indicates the weight of something. The toxicity of a substance: ionising radiation. It is invisible, tiny, but a tiny amount of it is extremely dangerous, whereas oxygen at low level could actually be toxic. It is not the PM. I am just saying it is --

David Kurten AM: The level of PM2.5s is --

Rikard Moen (Head of Occupational Health, TfL): The risk is not associated. All I am saying is that the smaller PMs can get into your lungs further, but if that is like oxygen, then it is no harm to you.

David Kurten AM: Oxygen is a tiny molecule. It is much less than 1 micron. You would measure it in nanometres, not micrometres, so that is a different sort of level.

Rikard Moen (Head of Occupational Health, TfL): The key point here is it is the toxicity. You have hazard. Everything is a hazard, but then your risk is dependent upon the effect of that hazard and how much you are exposed to it.

David Kurten AM: Are you saying that the legal limit coming in of 25 micrograms per cubic metre of PM2.5s is important or not? Is it important to get that level below 25 micrograms per cubic metre? That legal limit is coming in in 2020.

Peter McNaught (Director of Asset Operations, TfL): I believe it is important above ground where the chemical composition of the PM2.5 contains known carcinogens, mutagens, contains benzine, things that are known to cause harm to health. In the Underground, the PM2.5 is made up mainly from abrasion, so not from burning things. It is made up from wheel-rail interface and it is made up of iron oxide, of which there is no

evidence that iron oxide is a carcinogen, a mutagen or causes any harm to humans at the moment. I think it is important above ground where we know it causes harm. Below ground, if you were to put that standard across every metro in the world, they would not comply.

David Kurten AM: You are saying that it is not dependent on an absolute level, it is dependent on the composition of the particles and the materials in it?

Peter McNaught (Director of Asset Operations, TfL): It is dependent on the composition. It is important. We should all be trying to reduce it, but to try and apply the above-ground limits of known mutagens and ambient air to underground metro --

David Kurten AM: You mentioned benzine, which is --

Caroline Russell AM (Chair): David, could I just mention you are straying towards the section on health?

David Kurten AM: OK, sorry.

Caroline Russell AM (Chair): No, do not worry. I just wanted to alert you because Shaun [Bailey AM] will be wanting to come in. Also, David, Jenny has been indicating for a while that she wanted to come in.

David Kurten AM: I know. Sorry, Professor, yes.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): I wanted to say that, yes, I think it is great that there is going to be a new legal threshold for ambient air. We know that the ambient air in London is primarily from combustion. The majority of epidemiological studies - some have been done around factories and things but most of them that have been done in cities are related to combustion, sometimes from power and other things but mostly from traffic, and we know that that is very harmful. To get that down, get rid of cars. Electric vehicles also have emissions from tyres and brakes and this, that and the other. The composition is very different. The combustion particles are mostly a lot smaller than the particles in the Tube, so you have far more of them for a given mass. Yes, I think that that new legal limit is to be welcomed, but we do not have the evidence, and what we do have suggests that it may well be inappropriate to apply that to the Tube because it is very different particles, by and large. I do not know enough about it to be certain about that, and this uncertainty I think is one of the problems.

David Kurten AM: Thanks. I should get back to the point because I am straying off, as you said. There is one thing I just want to clarify. You mentioned benzine and you mentioned volatile organic compounds, but they are not PM2.5s because they are gaseous, are they not? You should not confuse volatile organic compounds and PM2.5s, which are the small solids. They are so small but that is why they do not settle. There is a difference there, isn't there? Benzine is not particulate matter. It is gaseous.

Peter McNaught (Director of Asset Operations, TfL): The point we tried to make was some substances are harmful and some --

David Kurten AM: Yes. Benzine is a class 1 carcinogen, obviously, but it is not PM2.5.

Peter McNaught (Director of Asset Operations, TfL): This could be a glass of white spirit. I could have another glass of water. I know which one I would rather drink.

David Kurten AM: Of course. My point is benzine is not a PM, is it? It is not particulate matter. When we talk about particulate matters, we have to stick to the things that are particulate matters and not confuse them with volatile organic compounds. Anyway, I will get back to my point.

Caroline Russell AM (Chair): David, get back to your questions.

David Kurten AM: I am sorry. I cannot help it. I just did some chemistry questions. Sorry.

Back to the thing, you do the dust monitoring reports. There was one that was due to be published, I understand, in May 2019, but it has not been published yet. When is that going to be published, the next dust monitoring report?

Rikard Moen (Head of Occupational Health, TfL): We are doing a lot of work with quite a few of the universities. I do not know which one in particular. King's have just published a report about six weeks ago. I do not know if it is that one you are referring to. This was linked to measurements in the network. It was very interesting. It was showing the linkage, as Pete [McNaught] was mentioning, at different times of day when the levels are highest. That report was published about six weeks ago. The last industrial hygiene report was just published in June [2019], just now, the last --

Caroline Russell AM (Chair): We had a letter from TfL from Jill Collis [Director of Health, Safety and Environment] saying, "We expect the next report to be published in May 2019". This was TfL's respirable airborne dust monitoring at various London Underground stations and train lines. I think there are two of them so far, all rail.

Rikard Moen (Head of Occupational Health, TfL): That one has been published.

Caroline Russell AM (Chair): We have one from August 2017, one from September 2016, and we were expecting one in May 2019.

Rikard Moen (Head of Occupational Health, TfL): The one you are showing me there was published at the beginning of this month.

Caroline Russell AM (Chair): Not on the website that we were able to find. If you can send it to us after the meeting, that would be great.

Rikard Moen (Head of Occupational Health, TfL): Yes. It was issued on 11 June [2019]. That is that one there. We can forward that to you.

David Kurten AM: Yes, that is great. Thank you. Yes, by 4-RAIL.

Rikard Moen (Head of Occupational Health, TfL): Yes, 4-RAIL's report.

David Kurten AM: OK, great.

Rikard Moen (Head of Occupational Health, TfL): King's also published a study probably about six weeks ago.

David Kurten AM: OK, fantastic. Just before I finish, I would like to ask you about the variations in your measurements across stations and different lines, and you talked about Hampstead, you talked about

Hammersmith. Hammersmith, also being the deepest station: have you found any patterns between station design or the levels and clusters of stations along a particular line, or is it all random? Is there any connection between the type of station, the lines and the levels of Tube dust?

Peter McNaught (Director of Asset Operations, TfL): There is definitely a connection between the deep Tube lines. We had a discussion earlier on where there was a concern raised about heavier trains. Our heaviest trains are the S8 trains on the Metropolitan line, but thankfully they run on the subsurface lines, which our measurements show the PM levels on the subsurface lines by their very nature -- there is more air circulating, so the concentrations do not build up nearly as much. We see the most concentrations on our deeper lines: Bakerloo, Central, Victoria, Piccadilly. That is where our higher concentrations are.

Equally, on our stations, again, if our stations are deep, cavernous stations with multiple deep lines running into them, we tend to see higher levels there. Oxford Circus, for example, is at the intersection of three of our deepest lines and tends to get higher readings than some of our other stations.

David Kurten AM: Yes, so there is less chance for the Tube dust to escape.

Peter McNaught (Director of Asset Operations, TfL): Less place for it to go.

David Kurten AM: Yes, right. Even if the trains are lighter, then it just builds up.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): It is worth pointing out that the increase in trains per hour has an impact, too. With newer signalling systems, trains can be closer together, which means more trains can be closer together in one area. I am sure you may be mentioning later stack events, which is a specific thing that is known to create a dust cloud event. In the areas with the newer signalling systems, where trains can be closer together and something happens, you have more trains backing up in a close area. That is known to create dust cloud events. How do we solve that problem? We have more people using the Tube. We have more people needing to use the Tube. We have more trains in one area. If something goes wrong, there is a ripple effect that can immediately create an unsafe environment again at that PTI.

Rikard Moen (Head of Occupational Health, TfL): It is very interesting, the data. You can track on the network, if you are a passenger, your exposure at each of the platforms. As Peter said, it is the depth, but then that starts to get less as you get close to the surface, two or three stops before. If you are travelling the whole length of that line, there are only parts of it where you are exposed to high levels. You can see on there, actually there was a breakdown across all the lines, and you can see District and Circle, negligible, but the Victoria line is --

David Kurten AM: Yes, the deep lines are obviously higher and the four Circle lines and the connected lines are much less. Yes. Absolutely.

Rikard Moen (Head of Occupational Health, TfL): The very good point there is that one of the main reasons why London Underground has higher dust levels than the other metros in the world is, yes, it is older, yes, it is deeper, but with the new efficiencies that we have, the trains do now move a lot closer together. As Peter [McNaught] says, at night there is no PM2 at all. As soon as the trains start running, the peak is when the trains are running at their most and then back again, that rush hour. That is one of the reasons why London Underground has higher levels than a lot of the other metros.

David Kurten AM: Yes. You have obviously done some work into understanding some of the variables that would cause high levels of Tube dust. Are you taking any of these things that you have said into account in working on stations and lines in order to try to reduce those levels?

Peter McNaught (Director of Asset Operations, TfL): Mainly in ventilation. We have not found a particular aspect of a station design that increases PM quantities. What we have found is if a station connects to a number of deep lines, then the PM levels are higher, because we know it is the deep lines that have the PM issue. I do not think it is the station design. I think it is the fact that it connects to those lines, and therefore is a conduit for air to get in and out. Therefore, the PM levels are higher at that station.

David Kurten AM: Yes, so it is lack of ventilation, number of lines, number of trains per hour.

Peter McNaught (Director of Asset Operations, TfL): Ventilation certainly in our new designs is something that we are taking seriously. In our older lines there are not many ventilation shafts. Certainly, from Barcelona, they did a study where they looked at the ventilation fans and the impact that can have, because the more air you can bring in, the more you can dilute the particulates and reduce the levels.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): Bouncing off that, when we tried to simulate something similar, to use the example of Barcelona, we found our equipment that could be bidirectional had not been maintained properly, and therefore we could not try that. We do have to have a conversation about basic maintenance and upkeep, what those regimes are. What has changed since 2003 in our upkeep regimes and our maintenance? If we cannot get the basics right, that is going to have a significant impact on what controls we currently have as well as the conversation we are going to have about what other controls we can introduce.

Literally, if you have a ventilation system that breaks a lot or that we do not fix as quickly as we used to, that is going to directly impact air quality.

David Kurten AM: OK, yes. Thank you very much.

Caroline Russell AM (Chair): I am now going to move us on to some questions from Shaun on the health risks associated with Tube dust.

Shaun Bailey AM: I think the upshot of the last section is just it seems to me that the composition of air in the Tube is slightly different to what it is at street level, which leads to a number of questions. It sounds like it is more dangerous at street level, so just exactly what are we pumping into the Tube? I just ask you to consider that.

Rikard Moen (Head of Occupational Health, TfL): Pump it the other way, yes.

Shaun Bailey AM: The Tube might be safer. There is no conclusive evidence about the toxicity or the morbidity of Tube dust. What is currently being done to build this level of evidence? We talked about what previous Mayors had or had not done, but of course they did not have the technology that we have now. The Professor explained how you captured air back then. We had a big conversation about what you could not do live then, which you may be able to do now. Of course, air quality is much more on people's minds than it was then, and I believe it was not the Mayor, it actually was a TfL Board Member who started pushing about what is happening in the Tube currently as we speak. It would be interesting to understand, is there anything new happening to look at the toxicity in the Tube?

Rikard Moen (Head of Occupational Health, TfL): To my recollection, yes. I will leave the epidemiology studies aside. That is what we are doing with King's College and Imperial. That is not answering your question. Specifically on the dust itself and the effect, one is looking at anybody who is really using the network. With our support and the Medical Research Council (MRC), King's College is repeating the study that they did on Oxford Street, which is where they take people with chronic obstructive pulmonary disease (COPD), so failing lungs, essentially. They monitor them walking around London. They are going to do the same study - and we have approved this and we are co-supporters of it - putting the same people into the Underground and measuring the effect on their respiratory and cardiovascular systems. They will then be able to use the control from the surface to see, is it worse? Is it better? You are taking a vulnerable population who already have significant pathology. Like asthmatics, it is the population that will be impacted the most by anything that is in the dust, whether it is toxic or not. That is a large, large project and a really exciting project. As I say, it is a repeat of the Oxford Street study that they did. That will take a while because it is really full-blown, and it is using St Bartholomew's Hospital, in co-ordination with them as well. That is looking at the health of the people.

To your question looking at the toxicity of the dust itself, we are working both with Queen Mary University, who is currently taking samples, and looking at the bit in the report, certain scientifically. The constituents within the dust in the Underground, as far as we know, have no health effects, but these are *in vitro* studies. In the laboratory, there does seem to an increase in what we call oxidative and inflammatory response. That does not seem to be replicated when you do the *in vivo*, in-body studies, but nonetheless that evidence is there. They are going to be taking that dust, as are Leicester University, and will then see in the laboratory what this response is. They will then try to correlate that back to the human. We are looking at the *in vivo* part of it, which is the people, and then the *in vitro* bit in the lab. There are two studies going on - one has started and one is due to start soon - to know how toxic this dust is.

Shaun Bailey AM: Just to quickly ask Cat, are you aware of any additional studies being done for and involving staff? The upshot of this will be beneficial for everybody who is near the Tube, but, of course, staff are in a slightly different situation; more time at the trackside on a day-to-day basis.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): I am not aware of anything else beyond what Pete has mentioned. There are some things that have been mentioned in the air quality committees that I have gone to that have involved station staff that I have never heard of. If that is simply a communication issue, we can address that. We can ensure as many people as consistently as possible take part. There are many things to take in the COMEAP report, but you mentioned before about the cultured cells. That is paragraph 27, where it says:

> *"One of the most consistent findings is that exposure to particles from subway systems, including London Underground, can induce inflammatory responses and oxidative stress in cultured human lung cells."*

Then paragraph 48, in conclusion, says:

> *"None of this evidence is directly transferrable to assessing the health risk to the travelling public from exposure to PM in the London Underground."*

What that says is we have to consistently keep on gathering this data. It needs to be a rolling programme. We need to have a long-term plan. My concern is that it is a bit hit-and-miss, and I have seen some genuinely innovative things done. I am not trying to diss you for the sake of it. What I am saying is what COMEAP said was, "We don't have enough scientific evidence to give you a qualitative response". We must gather that.

Shaun Bailey AM: It does sound like TfL are trying. The issue here - Professor, you may be able to give us some insight here - is how regular would this ongoing study need to be? I am asthmatic. I would love to be on that because I sometimes see the dust in the Tube and wonder, is that bad for me? I say that because I asked another question - that is the first question to the Professor - how regular would this study have to be? The other thing is you have talked about reporting to the public. How useful is that? Are we scaring people or are we empowering them? Where on the graph is this constantly telling me the state of the Tube dust level? What is the actual impact of that?

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): How regularly the studies need to be done I think would depend on how often things change. If you are studying what the effect of the air as it is and you know from detailed monitoring not only about the levels but also about the composition, that it has not changed, then unless there is a change to the sort of people using the Underground or working on the Underground or to the sorts of health conditions they are likely to have, then you should not need to do those studies too often. You need to be monitoring all those things to know if they changing, to know if you need to repeat the studies.

The thing about the *in vitro* study is it also does mention that the concentration is about two orders of magnitude higher than it would be, but something else I was reading yesterday was also saying that of course for the average concentration, there may be bits, particularly where the airways bifurcate and split, where more is deposited at certain points. Although overall it is a much higher level than you would be exposed to, there may be little bits of your lungs that are exposed to high levels. Again, in paragraph 29 it is saying that the inflammatory effects are greater for Underground particles than the ambient air, but the oxidative is less. You win some, you lose some. For long-term effects in cancer risk or the impacts on people with cancer or COPD, I am not sure.

I think the studies you have described are really important and I look forward to reading about that. Have I answered your question?

Shaun Bailey AM: I think you have.

Rikard Moen (Head of Occupational Health, TfL): Another important thing about research; once you do research, there are always conclusions. Inevitably, research says, "We should now study this".

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): "We need more research."

Rikard Moen (Head of Occupational Health, TfL): "We need more money. We need more research money to do something else." That is fine. You move the knowledge forward every time you do a research project. You would probably be guided by the findings in the research project to say, "This should be done in a year's time or ten years' time".

In answer to your second question, it is a tough question to answer. We would have no control. Yes, we are co-sponsors of this research, but as with all academic research, like the pharmaceutical companies, if you do not like the result, you cannot say, "No, we will not publish it". Is it in the public interest? I would tend to say yes. Would it scare the public? I do not think it would, but --

Shaun Bailey AM: I do not mean about the research. I open my app and I can see poor air quality which means I have to dodge somewhere. I am asking in that sense. What is interesting is the difference in the

composition. We have talked about burnt particles as opposed to abrasive particles, and we have talked about operational risk versus how dense a particular thing is. Are you helping me by continually giving me the evidence, or are you making me afraid of using the Tube?

Rikard Moen (Head of Occupational Health, TfL): It is a really, really good point. When the COMEAP report came out I was really disappointed in BBC London, who said the risk was 50 times higher, but they had not taken into account that it was not the risk that was 50 times higher, it was the PM2.5. Perhaps we may be behind the curve on telling, as we are today, what the true data is and explaining that it is not PM2.5 and its numbers that are the risk, it is what is in it. There have been a few articles this week. There was the chap with the backpack and there was an independent report last night. The media love scare stories, but our evidence is solid and very reassuring. We need to try to counteract that better so the public do not get scared. I would happily live in the Underground 24 hours a day and I would not be concerned about my health.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): I am not sure you have ever done seven-night shifts in a row there.

Rikard Moen (Head of Occupational Health, TfL): Maybe not.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): That was the question I did not answer. What is also important is what people would do instead. I mentioned Beijing and cycling at the beginning. If people had this information, were scared to use the Underground and sat in a car, where the air intake is from the car in front and their levels are much higher than the ambient air even as measured at roadside rather than further away, and they are sitting - many people consider public transport as active travel because most people walk one or other of the journeys to or from the station - overall the health risk is probably greater from not using the Tube if you are travelling in another way that is less healthy, or if you are not making the journey at home and being at risk of social isolation. It is not just what the health effects are. It is also looking at the other options and what the health impacts are of those.

Shaun Bailey AM: It is possible to mitigate that --

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): That is the absolute ethical conversation we need to have, and more Londoners use buses than the Tube. By that I mean more Londoners take a bus to get the Tube to take a bus. We need to be having conversations about what they are breathing in when they are sat on the bus on the way to the Tube, on their walk to work to get on another bus. That is where there needs to be an integrated approach. You are quite right; social exclusion, affordability, the amount of time. Is there a way that people do not need to take the Tube as much? If you cannot afford to live near where you work because you are priced out of London, your journey is going to be longer. There is a bigger, more complex debate to have.

Shaun Bailey AM: We are confined to the Tube here, but the reality is many, many people will always live far away from the centre because of the nature of our population growth, and also many people choose to live there because of other social reasons.

Just one small question I would direct mainly at the Professor, and I say small, and you are absolutely not going to agree with what I say next. What are the health impacts of the different components of Tube dust? Are there two or three things that we should be particularly worried about in the chemical composition of Tube dust, or not as the case may be?

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): The COMEAP members are far more knowledgeable about this than I am. If you look at paragraph 37 it is saying:

> *"The levels of copper, vanadium, cadmium, cobalt and zinc were not of toxicological concern for the general population. Arsenic, iron, manganese and nickel are unlikely to be of toxicological concern."*

Even when it comes to iron, going back several decades since I last looked at this, there is ferric and ferrous, and one of them is inert and one of them is not. One has two electrons missing and one has three electrons missing, and I cannot remember which way around it is. I know, for example, if you are taking iron to prevent or treat anaemia, one sort works and one sort does not because the body cannot absorb it. It is not even what the chemical composition is but what form it is in that affects it, and that needs to be studied by people far more specialist than I am.

Rikard Moen (Head of Occupational Health, TfL): I can answer if you want. The composition is non-ferrous, so it is ferrous oxide. Depending on which report you look at, anywhere between 45% to 70% is ferrous oxide. Iron is an essential part of the body, and there are no health effects --

Shaun Bailey AM: I can get my iron intake from Tube dust, then?

Rikard Moen (Head of Occupational Health, TfL): No, unfortunately not, because it does not go into your gut. If it went into your gut, yes, you could. Unfortunately, it comes into your lungs, and because they are large particles it gets ciliated back out again. At very, very high levels, chronic exposure, you can get a thing called siderosis. Normally your body can get rid of iron quick enough. It comes in, it comes back out again. It is not a problem. If you have chronic, long-term exposure - and probably 100-fold higher than you get on the Underground - then that deposits the iron in your lung. It is not harmful in any way. You just notice it on an X-ray. That is why they call it benign pneumoconiosis. That is the only health condition that iron can cause. As I say, that is at levels hundreds of times above.

Organic matter, what we produce from our skin and everything, about 10%. Calcium oxide is about 10%, and there are no health risks from calcium oxide. Elemental carbon is 7%.

Shaun Bailey AM: This goes back to your earlier comments about levels of exposure, legal limits, what is dangerous currently as you understand it, the chemical composition of the Tube dust. There are very few actively dangerous elements in it?

Rikard Moen (Head of Occupational Health, TfL): Precisely. Absolutely, 100%. That is what I was getting at in the very beginning. It is, how toxic is that stuff you are breathing in? There are lists of others - like cobalt, zinc, vanadium - that are at miniscule levels. You would find those anywhere.

Shaun Bailey AM: I am going to stop so the Chair can move on, but I think it falls to TfL to clarify these things. As an asthmatic, I can see the dust. It worries me. We need information, both staff and public, to help us understand what we are seeing so that we cannot worry, because we do not have a choice. Most people who use the Tube do not do it for the fun of it. They do it because they have to. It is important from a public health point of view to help us understand what is going on. The wider air quality conversation that is being spoken about: we are just transposing those details into the Tube.

Peter McNaught (Director of Asset Operations, TfL): We could probably do that. In the report that gets issued, we could probably have an explanation in there around the main composition.

Shaun Bailey AM: Yes. I take you to food labelling, which is one of the most horrific things in the universe for how it is complicated. You need to be a scientist to understand. The one thing that does work is that very simple traffic light system. You can look at it, "Well, this is too salty. I should probably buy peanuts with no salt on them". We need something like that.

Caroline Russell AM (Chair): One thing I was just going to say was, Shaun, obviously the particles we are talking about are so small you cannot actually see them, so the ones you are seeing are the bigger ones, but they probably indicate that there are smaller particles as well.

Shaun Bailey AM: You make my point for me because I am worried about these big particles that I can see, and I should not be. I should be worried about ones that I cannot see. That is the piece of learning --

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): The point that I was going to make was that whether you are talking about above ground or below ground, in general, if you can see it or smell it, that is not going to do you any harm. Hanging your sheets out and having them all turn black is fine if you do not mind washing them again.

Caroline Russell AM (Chair): It is annoying, but --

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): It is not fine, but those particles may not even get to your nose let alone into your lungs. It is the invisible smell-less stuff that is --

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): The visible stuff can, if you are doing an eight-hour shift --

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): It is not pleasant. It is like cigarette smoke. It can cause eye irritation and all these things --

Shaun Bailey AM: You have made my point for me because we are worried and/or focused on the wrong things. Help us to understand so we can focus on the right things.

Tony Arbour AM: I have just a simple, very brief question. Would it be fair to say from what we have heard - and I will ask you all the same question - that it is simply an urban myth that travelling below ground is worse than travelling above ground?

Peter McNaught (Director of Asset Operations, TfL): When you say, "an urban myth", it is a misunderstanding by people just looking at PM2.5 levels and not considering the chemical composition of what is in that.

Tony Arbour AM: Surely it is simpler than that. Either it is worse travelling underground than above ground. If it is worse travelling underground than above ground, it is not an urban myth, so --

Peter McNaught (Director of Asset Operations, TfL): It is an urban myth.

Tony Arbour AM: Is it an urban myth?

Rikard Moen (Head of Occupational Health, TfL): From a toxicology point of view, you are exposed to less hazardous chemicals underground than you are on the surface.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): Are we talking just about air pollution?

Tony Arbour AM: Yes.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): Probably, yes.

Tony Arbour AM: Does the RMT agree with that?

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): I do not agree with the way you are asking the question --

Tony Arbour AM: I am asking a question that the people outside can understand.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): Absolutely and quite rightly, as Shaun was saying, it is about having a genuine understanding about what the problems are. However, I am concerned that if TfL is acting on the defensive, we are not actually looking at what is important. Quite rightly, as you have both said, PM2.5 versus ambient air pollution are not comparable in the same terms and that is what the COMEAP report says. If we ask aggressive questions or try to exaggerate or make it a little bit of entertainment, we are not going to have those meaningful conversations.

Tony Arbour AM: It is not a question of entertainment. Precisely as my colleague has said and indeed people from TfL have said, there has been this frightening stuff going around, "It is dangerous. You cannot go on the Underground", and they list all these possible things that might be there, which are so miniscule that they could not conceivable have any effect. Surely our function as a public body ought to be to go out and say, "This is nonsense. This is an urban myth".

Caroline Russell AM (Chair): We are not hearing that it is nonsense. We are hearing that there are very --

Tony Arbour AM: It is pretty close to nonsense.

Caroline Russell AM (Chair): Tony, if I could just say, one of the things I was going to bring in is that if a commuter were to spend half an hour on the Underground, say, at 302 micrograms per cubic metre on the Jubilee line, twice a day, five days a week, for 48 weeks of the year, and the rest of the time they would spend at an urban background level, which is about 18 micrograms per cubic metre, their average exposure across a year would be about 26 micrograms per cubic metre, which is similar to spending the whole year next to a busy road. Those regular high exposures to PM2.5 and smaller particles could be having an impact on people's health across a year. Is that right or is that wrong?

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): Let me answer the question. Yes, it is an urban myth that it is worse, but that does not mean we should not be trying to reduce both of them.

Tony Arbour AM: I am not suggesting that. I would agree with that.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): Just because A is better or worse than B does not mean that there may not be some harms from both.

Tony Arbour AM: Obviously, I agree with that, but I have been reading all this stuff in the paper. I travel on the Underground every day. Should I be going down chewing my fingernails? No, of course I should not and we should be shouting it from -- I nearly said "from the rooftops" but certainly from this building. It is perfectly OK.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): There is a difference between saying it is perfectly OK and saying it is not worse than breathing ambient air.

Caroline Russell AM (Chair): I agree with you, Tony. We do not want people to stop using the Tube because, as Jenny has been pointing out, if you are taking active travel and walking up and down escalators and things like that, you are getting more health benefits, but we also need to understand what the exposures are, particularly for people who are working on the Tube and who are in there for much longer. Yes, you were going to come back?

Peter McNaught (Director of Asset Operations, TfL): I said at the start that we take very seriously the health of our customers and of our staff. We take regular samples. We have a regime that we implement to keep the levels well below the health and safety exposure limits. Indeed, at the working group with the trade unions and our engineers, we set our terms of reference to aim for the IOM levels, which are a quarter of the HSE limits. The fact that it is more harmful is an urban myth, but it is not making us rest on our laurels. We are driving to reduce those particulates because breathing anything into your lungs that is a foreign body is not desirable.

Caroline Russell AM (Chair): David, you wanted to come in, if you can be brief?

David Kurten AM: Just to pick up on something you said, Rikard, about the decomposition of the PM2.5s, it is a good discussion that it is the individual chemicals in the mix and you perhaps need to take each one individually and assess the risks of each one individually, which is what you would normally do for any particular substance.

You did mention that 7% was elemental carbon. That worries me because that is one of the things that does come out of vehicles with internal combustion engines above ground. What are the risks of elemental carbon colloids or small particles? Is that a carcinogen?

Rikard Moen (Head of Occupational Health, TfL): That is why I used the word "elemental". Carbon on its own is not a health risk. I do not know what the Professor thinks.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): I do not think so.

Rikard Moen (Head of Occupational Health, TfL): I did research. I re-researched that before I came here today so that I was able to confidently say that I certainly could not find any evidence that that is a health risk, certainly not carcinogenic.

David Kurten AM: Of course, there are different forms of carbon. We can get soot, graphite, coal, coke and so on. They would all perhaps have different risks in different forms. What sort of form is the elemental carbon in? Is it graphite? Is it amorphous? Is it just particles?

Peter McNaught (Director of Asset Operations, TfL): It is graphite from carbon brushes and from stick lubricants on the phalanges of wheels. It is not from the combustion of hydrocarbons.

David Kurten AM: It is in the form of graphite?

Peter McNaught (Director of Asset Operations, TfL): There is a lot of graphite from this stick lubrication on the axles.

David Kurten AM: That 7% carbon is not --

Rikard Moen (Head of Occupational Health, TfL): That is the key point. It is not from combustion. It is from the brushes.

Peter McNaught (Director of Asset Operations, TfL): Yes, the brushes on the motors and then we have stick lubrication on the flanges of the wheels on the trains to improve the wheel-rail interface and stop excessive wear between the rail and the wheel.

David Kurten AM: It will be a different form than in, say, the soot? It would not be --

Peter McNaught (Director of Asset Operations, TfL): Very much so, yes.

Leonie Cooper AM (Deputy Chair): I wanted to come back to this point about the urban myth and whether the dust in the Tube is more or less dangerous because that is not actually necessarily a very useful comparison that Tony [Arbour AM] seemed to be bringing in there. I want to come back to really the point that I was trying to make earlier. It is that looking at it and having more detail would give us a much better position to know whether some of the points that we are now raising -- the composition of the dust is clearly very different from ambient dust above the ground, but knowing more is not a bad thing. We would then be in a much better position to know whether urban concern, shall we say, is in any size or shape justified or indeed political parties deciding to run campaigns saying, "Scary, lots of Tube dust. The Mayor should be more doing more".

Tony Arbour AM: You are the one who has brought in all the politics about the Mayor, this one and the other Mayor and things like that.

Leonie Cooper AM (Deputy Chair): There are people running campaigns that say that at the moment.

Tony Arbour AM: You are the one --

Leonie Cooper AM (Deputy Chair): No, it is not me who is running that campaign. I will give you the name of the person who is, if you would like, Tony.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): It is worth pointing out that paragraph 45 of the COMEAP report said that it is not clear whether subway PM is more or less toxic than outdoor PM, who, as you said, are the experts on the matter.

Leonie Cooper AM (Deputy Chair): Knowing more is a good thing.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): Absolutely. I am thinking of the various studies that Rikard [Moen] has mentioned, both the epidemiological ones and the *in vivo* measurements on individuals. Not just their exposure but also what happens to their cardiorespiratory systems is key. If you are having this meeting in a year or two's time, there will be far more evidence to be able to answer that question more accurately.

Leonie Cooper AM (Deputy Chair): If we knew more, then perhaps some people running scaremongering political campaigns would not be happening.

Tony Arbour AM: Dear, dear.

Shaun Bailey AM: I have a very basic question. It may well have been covered. What are the biggest single contributors to the particulates in the system?

Peter McNaught (Director of Asset Operations, TfL): The rail-wheel interface.

Shaun Bailey AM: This is an obvious one, and you must be looking at technology to try to change the situation?

Peter McNaught (Director of Asset Operations, TfL): Hence the stick lubrication on the flanges of the trains. All the new S stock are fitted with those. We have them fitted on the Jubilee line. We have them fitted on the Northern line. We have them fitted on the Central line. The new trains that we have ordered from Siemens will have them. That is to gradually make sure that we are reducing that wear between the wheel and the rail.

Shaun Bailey AM: DC motors have brushes. The new stepper AC motors do not. Are we going that way as well?

Peter McNaught (Director of Asset Operations, TfL): That is correct.

Shaun Bailey AM: Are those stepper motor trains - new motors, sorry - more prevalent or less prevalent?

Peter McNaught (Director of Asset Operations, TfL): Again, the entire S stock fleet is AC. The Jubilee line is AC. The Northern line is AC. We are converting the Central line to AC now. The new trains coming from Siemens for the Piccadilly line will be AC, as will the follow-on trains for the Bakerloo line.

Shaun Bailey AM: How long have you have been moving to these newer motors?

Peter McNaught (Director of Asset Operations, TfL): Since the introduction of the Jubilee line. On the Jubilee line and the Northern line, that stock is all being fitted. On the Central line we have put a programme in.

Shaun Bailey AM: In what year did you start this programme?

Peter McNaught (Director of Asset Operations, TfL): In 1996 the Jubilee line started to --

Shaun Bailey AM: Work has been done all along?

Peter McNaught (Director of Asset Operations, TfL): Yes.

Shaun Bailey AM: Thank you very much.

Caroline Russell AM (Chair): I am going to take us back into looking at occupational exposure. Do you believe that the occupational exposure standards that are set by the HSE are adequate on the Underground?

Peter McNaught (Director of Asset Operations, TfL): Yes.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): No.

Caroline Russell AM (Chair): Let us start with Cat.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): No, I do not. That is TfL's view, too. I have been in meetings where they have said, "We aim to get 50% below what the legislation says and where that is not possible 25%", because the HSE itself admits that just because something is just below the legal limit, it does not actually mean it is safe.

I am very comfortable to say and very confident, though, and again that we have to look at broader legislation. We also need to consider the different legislation that COMEAP looked at because they looked at HSE regulations and European Union (EU) directives and EU regulations. We need to have an understanding of why we have some things in legislation and why we do not or why some things are EU directives because there has been resistance, perhaps, to bring that in nationally and that has been brought in by EU regulation. The same applies for a lot of health and safety regulation. It is not adequate. Just as you said, we could not measure PM2.5 in 2003 properly, but we have legislation. The latest is 2005, the main bit of legislation that we use. There are several bits. If we could not measure something in 2003, one of our main bits of legislation is from 2005, but if it is 2019, no.

Peter McNaught (Director of Asset Operations, TfL): Based on the knowledge and understanding they had at the time, the HSE set limits. I believe they were right at the time and I will comply with them at the time. If I can exceed and do much better than complying with them, why would I not do that? Hence the discussion we had when we set up the working group to look at particulates. We said we would aim for the IOM limits because we can and it is better to do that than just to comply with HSE limits. Based on the knowledge they have, they set limits on their understanding of the toxicity of those elements. It is accurate what they do with the knowledge they have at the time. I agree that they are right.

Caroline Russell AM (Chair): Do you think they should be updated given now that we can measure --

Peter McNaught (Director of Asset Operations, TfL): They should be reviewed based on the modern understanding of the toxicity of certain elements, yes.

Rikard Moen (Head of Occupational Health, TfL): The HSE Laboratory in Buxton is constantly reviewing toxicology and the limits are set by that. As I mentioned earlier, there is an OEL and then there is an MEL. If it is a substance that is not known to have a health effect, it will have an OEL. If it is known to have a health effect, you will have a MEL. All the ones that we have are bound by OELs. However, in all risk management that is the limit that is, as we say, as low as reasonably practicable (ALARP). When it is an OEL, you reduce it ALARP. If it is a MEL, it is not just ALARP; you have to reduce it. It is a regulated requirement. At all times,

you are trying to reduce the levels ALARP, which is all the cleaning regimes that Peter [McNaught] has been working on.

To reassure you, the HSE limit in the UK is 4 micrograms per cubic metre. The IOM has set it at a quarter of that at 1 microgram per cubic metre. On average, a simulated passenger journey is about 0.1 or 0.2. This is averaged over eight hours. This is an eight-hour time-weighted average (TWA). If you were to travel for eight hours, you would get about 0.1 or 0.2 micrograms per cubic metre. A train operator is a bit higher than that, about 0.2 to 0.5, still half of the IOM limit, remembering that the HSE limit is 4. It is an eighth of that. For the customer service assistants, it would depend on the platform. It varies from 0.08 to 0.6. Interestingly, the platform staff at the high-risk stations do get a little bit more exposure than the drivers.

To put that into context, the United States (US) which has the Occupational Safety and Health Administration (OSHA) as the equivalent of our HSE. You know how litigious the US is and how tightly controlled things are over there. They have the limit at 5 micrograms. Their limit is higher than the HSE.

To answer your question about a review, absolutely. I would suspect it is constantly being reviewed, but I am very comfortable that 4 micrograms is the right level. We work to 1 microgram in any case.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): I would just add that as a health and safety rep, my version of 'reasonable' is often different to TfL's version of 'reasonable'. There are times when TfL has said, "We have made this ALARP", and in my experience that is not as ALARP as it could be.

Shaun Bailey AM: With these levels here, we are talking about long-term chronic health issues that could arise. These levels are set and you are responsible for them. I want to go back to something Cat said about the everyday irritant. Your eyes are running. Your throat is a bit sore. By the way, as an asthmatic, an asthma attack is a major event. I just want to put that out there.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): Yes, and very difficult to have in a public place as well, not that you choose where that happens, but there are other impacts about something like that happening in a public space as well.

Shaun Bailey AM: Yes. Unfortunately I have a personal horrific history on that. Where is the interface? Let us take out the animosity. What work could TfL do to look at those things and to mitigate them? It could just be a case of taking a brown inhaler because your shift looks different this week. Could TfL do something like issue equipment? Is somebody looking at that? Of course, you legally might pass, but is there a duty of care to make life easier with fewer days off work and looking forward to going to work because you are not going to be ill?

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): The agreements that we have in place at the moment I hope we will improve beyond where they are. If you are a member of station staff and you feel agitated in some way, you withdraw, but that cannot be a permanent solution because, as I said before, the PTI is a critical area and we need staff there. We have also had a reduction in our staff and so there are not necessarily available staff that could circulate and take somebody's place. Therefore, as much as I am responsible as a health and safety representative for station staff and want them to withdraw and not expose themselves, that person not being there introduces another risk. The solution must be to remove the dust.

We can also have a conversation about the fact that train drivers can wear dust masks but station staff cannot. I would rather the station staff remove themselves from the area than wear a mask, but then we need enough staff to do that and we need a long-term plan to reduce the dust. That is going to be the safest thing for the public and the staff, when there is not dust that is irritating staff and when staff remain in that critical area of the station environment to get people back and forth from work as safely as possible.

Caroline Russell AM (Chair): Finally on this occupational thing, it is discussed as an occupational exposure but not as a travelling exposure limit. Do you think that is good enough, or do you think that you should be looking at the exposure of the travelling public?

Rikard Moen (Head of Occupational Health, TfL): We do simulated journeys. I mentioned the average numbers that we get for that and we do that on an ongoing basis. The difference between the public and our staff is the length of time that they are on the network. An eight-hour TWA is what you would be exposed to over eight hours, whereas for a member of the public one hour maybe two hours maximum they would be exposed to that.

If we were to apply a level, the level would be higher than it would be for somebody who is working there all day. The customer level is a lot lower than the station staff, who do have the highest exposure.

Caroline Russell AM (Chair): Actually doing it as a workplace --

Rikard Moen (Head of Occupational Health, TfL): Yes, by helping in the workplace, the knock-on effect is even better for the public.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): With the caveat that there may be more people who are passengers or are potential passengers but would not work there and who may be particularly susceptible. There may be people in the same way as there are asthmatics who used not to go into shopping malls until they went smoke-free or had difficulties going to the theatre because of being smoked over. There are potentially some passengers who might have problems, but in general I would totally agree that if you get it right for the staff, it must be OK for the passengers.

Caroline Russell AM (Chair): For instance, TfL gives advice to passengers when it is hot to carry water and to not get on the Tube if you are feeling unwell because it is easier to help you if you are at a station. Do you think that TfL should be offering advice about levels of Tube dust so that those people for whom exposure is more of a problem - people travelling with very small children, elderly people or people with COPD or asthma - know and understand when the Tube dust levels might be particularly high?

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): Can we wait for the results of those studies? At the moment we do not know.

Rikard Moen (Head of Occupational Health, TfL): We do not know.

Caroline Russell AM (Chair): When are we expecting the results of these studies?

Rikard Moen (Head of Occupational Health, TfL): I suspect the COPD study will probably be about 12 months.

Caroline Russell AM (Chair): Do you know if the high episodes of Tube dust track high air pollution episodes in the ambient air outside?

Rikard Moen (Head of Occupational Health, TfL): It is purely related to the train movement and which time of day.

Caroline Russell AM (Chair): You could have a period of high air pollution exposure risk out in the street but on the Tube --

Rikard Moen (Head of Occupational Health, TfL): There is no correlation. It is quite striking. At night there is nothing and then at rush hour it goes like this. It comes back down to quite a low level and then at rush hour it comes back up again. It is as distinct as that.

Peter McNaught (Director of Asset Operations, TfL): We have noticed from our research that there may be a bit of a seasonal effect. When the entire system is warmer and dryer, we get higher readings, but it does not correlate. Some days we can have above ground high air pollution. Ours does not change like that.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): The circulation of dust, as with the Bakerloo line, if you cannot remove all the dust, what is safer; it circulating or it being still on the ground and then disturbed and then dust events? Following no trains overnight in areas that do not have the Night Tube or if it is the weekend, the dust settles and then it is kicked up again.

Caroline Russell AM (Chair): When you say, "Let us wait for these studies to come out in about a year's time", if there is a risk that these studies are going to show that there is a problem in terms of people being exposed to this dust, would it not make sense for TfL to issue the warnings about high Tube dust days anyway?

Rikard Moen (Head of Occupational Health, TfL): Can I answer the original question before I answer that one? From a health perspective, I do not have concern. I certainly agree that the most exposed population is the very young and the very old and the immunocompromised, but from what I see here I do not have a concern for babies, young children, the elderly or the immunocompromised. We should not be seeing more incidents of asthma because it is not asthmogenic. Yes, it might have an irritant effect, but it is not something that should set off asthma. From what I see in front of me now, we do not need to say to the public, "You should not travel at rush hour or if you are an 85-year-old with COPD".

Caroline Russell AM (Chair): There might be other reasons why you might not want to travel in rush hour.

Rikard Moen (Head of Occupational Health, TfL): Yes. As the Professor [Jenny Mindell] said, it almost becomes self-selecting. If you have bad lungs and you have bad COPD, it may well be that the higher levels of metal in the air affects your breathing, as it would do if you are cooking on a gas stove. When you cook on a gas stove, you are hitting 5 milligrams per cubic metre. When you are burning a wood stove, you are hitting 25 milligrams per cubic metre. As a person with COPD, you would not light a fire in the house and would probably cook with electricity and not gas. They would regulate that. Would I say that a person with COPD should not go on the Underground? No, I have not seen any evidence that would say they should not.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): Can I just add that I disagree? This is a conversation about data transparency. It is not about TfL instructing people what to do or not to do. It is about making that information available. If you go on the gov.uk website, there is a huge amount of data on data transparency and so I do not believe that it would be right ethically to say, "We are deciding not to give you that information", if you have that information. However, that is complicated by the fact that we are providing a public service but are not public servants.

Rikard Moen (Head of Occupational Health, TfL): Chair, with all respect, that is not what I was saying. We are sharing the data. Everything we have here - most of it - is all shared anyway. What I was meaning was not to give out advice --

Caroline Russell AM (Chair): Not the warnings?

Rikard Moen (Head of Occupational Health, TfL): Not warnings.

Peter McNaught (Director of Asset Operations, TfL): Would we put out tannoy announcements telling people to move away from the Bakerloo line? No, definitely not. If the reports come back and we need to consider it, but at the moment we do not know if there is any impact on vulnerable individuals from the composition of dust in the Underground. I would be worried about where those people would then try to go. What line would they go on? Would they try to take the bus? What else would they do?

Caroline Russell AM (Chair): Yes. Thank you.

Leonie Cooper AM (Deputy Chair): How are you measuring the effectiveness of the technologies and measures that are currently being used to address the Tube dust?

Peter McNaught (Director of Asset Operations, TfL): By our continual sampling process. When the Mayor asked us to focus on this, we enhanced our cleaning regime and that has been ongoing now and continues. It is based on a graded inspection. Every part of the Underground is inspected at least every 48 hours and then the cleaning is targeted at the areas where we have dust building up to keep the cleanliness correct. I think of it as a bit like a river. As a river flows down, the sediment gets deposited at certain places. The air flow in the Underground is similar. We get certain places where we get more dust gathering than in others and so we target and try to make sure we are cleaning regularly in places where we build up the dust. In addition to that enhancement, we have been trialling various things.

Leonie Cooper AM (Deputy Chair): Presumably those locations where it builds up are known to you in the sense that the Underground does not meander around like a river. It does not move about.

Peter McNaught (Director of Asset Operations, TfL): That is correct.

Leonie Cooper AM (Deputy Chair): It runs in the same places and so the build-ups will always be in the same places and you can send your machines specifically there.

Peter McNaught (Director of Asset Operations, TfL): Yes, there are certain places that we clean every 24 hours. Every night we clean some places because of the build-up.

We have been carrying out a number of trials to improve that cleaning regime. We started in 2016 when we picked the 42 dirtiest stations and we cleaned through the station platforms. At some of the stations we cleaned 50 metres either side and at other stations we cleaned all the way to the next station. We then analysed the results from that because at that time we used two different suppliers with two different methodologies and we picked the one that gave us the best results.

We rolled on to carry out a trial of the entire tunnel section of the Bakerloo line from Queen's Park all the way down to Elephant and Castle. We did a deep-clean of that entire section. We then monitored the dust levels

after that and we found that although initially it helped, actually the PM levels in the tunnel returned very quickly to the same as before.

That made us go back and look at our methodology and we tried to look at --

Leonie Cooper AM (Deputy Chair): When were the 42 dirtiest, sorry?

Peter McNaught (Director of Asset Operations, TfL): That was 2017 on the Bakerloo line.

Leonie Cooper AM (Deputy Chair): Do you have that list of the 42 dirtiest stations?

Peter McNaught (Director of Asset Operations, TfL): I do, yes. We have provided it before but I can provide it again.

Leonie Cooper AM (Deputy Chair): That would be good.

Peter McNaught (Director of Asset Operations, TfL): Then, at the end of 2017, we carried a dust suppressant trial in the Waterloo & City line. We sprayed a mild detergent. We had to get it approved to make sure that it was safer than the dust and also we had to get it approved through all of our signalling and the power community to make sure that it did not cause any problem with our cables or our equipment. We sprayed a suppressant on the entire length of the Waterloo & City line and we have been monitoring that since December [2018] because we wanted to understand the longevity of the improvement. We started off and saw a 50% reduction in the particulates. We are now five months in. We have one more sample to take at the end of this month but we are still seeing a 40% reduction in particulates at Waterloo. It is looking promising on that trial.

Leonie Cooper AM (Deputy Chair): Presumably the staff are being given appropriate equipment to ensure that when they are doing these cleaning activities, there is no increased harm to them from spraying things on the line or anything else. I would assume that Cat is very much on the case on those sorts of things.

Peter McNaught (Director of Asset Operations, TfL): Definitely. The engineering staff when they are doing the cleaning; you have got an open invite to come on 11 July [2019] and you could possibly come to see it happen.

Leonie Cooper AM (Deputy Chair): Yes, we are coming to spray ourselves. We are looking forward to wearing quite a lot of personal protective equipment (PPE). It sounds like a PPE type of occasion to me.

Peter McNaught (Director of Asset Operations, TfL): Definitely.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): You will probably be wearing more than the station staff do!

Peter McNaught (Director of Asset Operations, TfL): There is the suppressant trial, but we have also recently enhanced it. We have a massive trolley-based vacuum cleaner that we are now using to clean the Bakerloo line again because the Bakerloo line, from our readings, is on a line basis the highest average line for particulates. We are going back in there and we are doing that tunnel section again. Working through it is going to take a while. We have another 80 shifts to do. By September [2019] we will have been back through that entire tunnel section with this further enhanced cleaning regime. If that is a success, then that will be ruled into the enhanced cleaning that we put in place in 2016.

In answer to your question, we will gauge the success by continually monitoring after we have done these trials to look at whether it has improved and whether it has a long effect. In the Bakerloo line trial, it improved but then very quickly went back. We have to get that right.

Leonie Cooper AM (Deputy Chair): This is not the only thing that you are doing. You have been looking at new braking technologies as well, I understand, the regenerative braking and the rheostatic braking. Is using the regenerative braking improving the position in terms of the number of particles being produced?

Peter McNaught (Director of Asset Operations, TfL): Definitely. The regenerative braking uses the electrical system on the train to slow it down. The friction brakes come on initially and then the traction system turns the train's motors into generators and slows the train down. Only down to the last 10 kilometres per hour, the friction brakes have to come back on and stop the train. That energy from the slowing of the train is converted and dumped back into the power rails for another train to use to power itself away. It not only saves energy but stops the --

Leonie Cooper AM (Deputy Chair): You are not only saving the number of particles being produced, but it is also allowing you to reuse that energy. Are you managing to reduce the London Underground electricity bill, which I understand is --

Peter McNaught (Director of Asset Operations, TfL): Considerably big.

Leonie Cooper AM (Deputy Chair): Yes, it is my understanding that is the largest in London.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): The numbers of trains per hour are massively different, understandably, to how they were a decade ago. If your brakes are contributing to the air in such a significant way and there are more trains -- there are not going to be fewer trains in our future. There are going to be more. We have signalling upgrades going on right now to ensure that we can have more trains per hour running on different lines.

Shaun Bailey AM: Surely that is a case of efficiencies. While signalling upgrades mean trains are running --

Leonie Cooper AM (Deputy Chair): It is always good to interrupt people's questions, is it not?

Caroline Russell AM (Chair): Shaun, can you come through the Chair, please?

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): I am not complaining that we are upgrading our system. I am saying that if we are running more trains and that is the most significant contributor to air quality, then we have to bear that in mind in how we are collecting our data and how we are tackling the problem.

Peter McNaught (Director of Asset Operations, TfL): It is a very good point. When people look at the particulate levels on London Underground compared to other metros, we have one of the oldest metros in the world. As a result, many of our tunnels were dug by hand. They are a narrow gauge, which means our trains are much smaller and much tighter with fewer people in them. We take pride in the Victoria line, where we run 36 trains per hour. It is the fourth most intense service in the world. However, the Hong Kong Metro to carry the same number of passengers would only have to run 17 trains per hour. We are running to move the same number of people that the bigger, more modern metros with wider, longer trains could move much more easily. That frequency of wheel-rail interface generates more particulates.

Leonie Cooper AM (Deputy Chair): There are the driving techniques that you can use like the one that you have just been talking about where you use the regenerative braking. I have a hybrid car. When I got my first hybrid car, I was given a lot of instructions about how to brake in a very different way. You just take your foot off the accelerator and then the regenerative braking will kick in. The kinetic energy would then go into the electric motor. If you are in a borough where there is a 20-miles-an-hour zone, you can pretty much drive around on the electric motor all the time.

I am just wondering whether taking your foot off the accelerator - I know it is all done by algorithms but having the trains coasting from further out into the stations, is something that you are now implementing? It will really save a lot of energy and save a lot of particle production as well.

Peter McNaught (Director of Asset Operations, TfL): There are two things. Yes, in answer to your first question, we are working with the signalling manufacturers. The early automatic signalling systems would basically link an on/off switch and the train was either motoring or braking. It got to the stage that when it got up to the speed that it wanted to go at, it was cycling between motor and brake. We are working with the signalling manufacturers now --

Leonie Cooper AM (Deputy Chair): I believe it is Alstom?

Peter McNaught (Director of Asset Operations, TfL): -- to introduce green automatic train control, where we have a coast in there as well so that we do not have this constant use of energy. However, we do come up against the dilemma between the rate of frequency that you want in the journey time and the number of customers who want to use our service. On the Victoria line, where we are running 36 trains per hour, every second we want that train to be either accelerating or decelerating. If we start to let it gently coast into the platform, suddenly 36 trains per hour may become 32 and we will get overcrowding. We are constantly battling between the number of customers who went to use our system and the frequency we need to run and how we can introduce less strenuous, dust-creating technology.

Leonie Cooper AM (Deputy Chair): I was going to ask you about the update on the Four Lines Modernisation project, but we touched on that earlier and you said that there will be an update on progress on that coming relatively soon.

Peter McNaught (Director of Asset Operations, TfL): Yes.

Leonie Cooper AM (Deputy Chair): We have just talked about the cleaning. With all these different methodologies that you are using, when do you think you will be in a position to say, "This is the one that is working the best"? It sounds like the one that you use on the Bakerloo line is probably not going to be carried forward, but there are some other methods. Spraying the mild detergent had 50% efficacy and then 40% still some time afterwards. That might be the best one.

When will TfL have decided which enhanced cleaning regime is the best? Then is it going to be rolled out across the entire network?

Peter McNaught (Director of Asset Operations, TfL): Once we get the ones that are the best and the ones that are practical to roll out, we will implement them. Some of these things I am working on just now. I mentioned the new deep clean of the Bakerloo line that we started on 17 June [2019]. We still have another 80 shifts to do of that cleaning. That is a further 9 kilometres of track that we need to clean. In about

September [2019] that work will be finished, but then we would like to take particulate readings probably for about three months after that to understand the longer-term impact of that cleaning.

We have also started a light trolley vacuum trial between Barons Court and Earl's Court on the Piccadilly line, which will be complete on 4 July [2019] and we will start to take readings in the week after that. Probably three months after that we will know if that is a good option.

Then, for the dust suppression, we are going to do a light clean with the trolley-based vacuum and then put the suppressant on. That trial is due to start in July [2019] and it is going to occur down at the bottom end of the Northern line. Again, it will probably take us a couple of weeks to clean it and suppress it and then we would want to take the readings for probably three months after that to make sure of the longevity.

Leonie Cooper AM (Deputy Chair): I might be able to help you with some data about what is going on at the bottom end of the Northern line as I use it pretty much every day and I could probably rope in a few colleagues, but I am not sure it would be very scientific. It would be more user experience.

It sounds as though you have two or three things, some of which you will not have finished the analysis of until, say, December of this year. You will probably then want to publish the results. Would we be able to look at what comes out of all of this?

Peter McNaught (Director of Asset Operations, TfL): Yes, we can publish the results. By September [2019] we will be able to inform you of whether we are going to --

Leonie Cooper AM (Deputy Chair): Have a couple of them.

Peter McNaught (Director of Asset Operations, TfL): -- include the trolley-based vacuum in our enhanced programme we put in place in 2016. At the moment the employees still use backpack vacuum cleaners. We may swap them for this trolley based on the results of this trial --

Leonie Cooper AM (Deputy Chair): We would like to be kept up to date with that. It would be helpful for us if you could let us know what the outcome of that is and then also the one where we will not know the results until December [2019]. We would also probably like to know about that. What would then be the timeline after you have the results in from all three for introducing anything across the whole of the network? Would that start in early 2020?

Peter McNaught (Director of Asset Operations, TfL): Definitely.

Leonie Cooper AM (Deputy Chair): Early 2020.

Caroline Russell AM (Chair): You were saying earlier.

Leonie Cooper AM (Deputy Chair): On the cleaning.

Peter McNaught (Director of Asset Operations, TfL): If the trolley-based vacuum is proven to be OK in September [2019], we would adopt that into the regime in September.

Leonie Cooper AM (Deputy Chair): From September [2019]?

Caroline Russell AM (Chair): For the whole network?

Peter McNaught (Director of Asset Operations, TfL): Then, if the suppressant is deemed successful, we will then adopt that as well. It is purely based on how quickly we can get the equipment to the workers.

Leonie Cooper AM (Deputy Chair): One of the things that somebody did suggest, although I understand there are issues relating to then the air pressure as the trains come into the stations, is the idea of having the type of barrier doors installed on the Jubilee line. Using those on all stations might be helpful in terms of dust suppression on the platform. Is that correct? You cannot completely seal it off at the top because, otherwise, that would create quite a serious problem. It might be fun but we are not looking for quite that much fun.

Peter McNaught (Director of Asset Operations, TfL): There are a few things for me. One: you have hit the nail on the head. The barriers to stop human beings falling down the platform-train interface do not go all the way up to the ceiling and so the dust can come whistling through and come over the top and seal it in nicely with the customers.

The other thing again comes back to the age of our Underground and the fact that many of our tunnels were dug by hand. People went where the digging was easy and so we have a lot of curves. We have a lot of stations with curves on the platforms. Curved platforms and platform-edge doors (PEDs) do not go well together.

We also have platforms, if you imagine, at the north end of the Bakerloo line or the north end of the Metropolitan line where the Metropolitan and Piccadilly lines serve the same stations or where the Overground and the Bakerloo lines serve the same stations. The doors on those trains are not at the same place and so the PEDs then do not line up, depending on the train. It is not really practical for us to deal with that.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): PEDs do not exist just to stop passengers falling. They do manage air flow. There is a bit more to them than that. Also, the S stock that we have been talking about was not bespoke for the Underground, which is why it also creates bigger gaps between the train and the platform. That is why we have had so many problems, particularly at Baker Street.

Leonie Cooper AM (Deputy Chair): What about other things, then? That sounds impractical in many stations for the reasons we have just outlined because they cannot go right to the top. I am not sure how much of a contribution barrier doors can really make. What about advanced ventilation systems and the electrostatic precipitator as part of the enhanced cleaning process? Are either of those things that you are looking into?

Peter McNaught (Director of Asset Operations, TfL): Certainly on the ventilation, we got in touch with Barcelona, where they had done a study around the direction of their fans. If you imagine, all our fans on the Underground suck air of out of the tunnel and blow it out into the open. In Barcelona, they found that if they reversed the fans and sucked the air in from the outside and pushed it in, it almost halved the particulates.

We immediately thought, "Here is a silver bullet. We need to go and look at it in the Underground", but we found that many of our fans are so old that they are not even bidirectional. They run only in one direction. The ones that are bidirectional have run in the same direction for 15 years. For anybody who knows anything about bearings, if you suddenly try to change the direction, it is going to fail. We have a programme of work to get our existing fans to a level that can enable us to trial that --

Leonie Cooper AM (Deputy Chair): A trip to Barcelona sounds as though it would be very valuable because it would be nice to see what they have in operation over there. After Caroline [Russell AM] has made the arrangements for us to go down the Tube and have a look at the cleaning here, we need to go to Barcelona. I am kidding.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): Can I ask what the ambient air pollution levels are like in those areas of Barcelona compared with central London? Might you be solving one problem and causing another?

Peter McNaught (Director of Asset Operations, TfL): We could be bringing in air with a lower PM level and so it makes our overall PM level look lower, but we could be bringing in PM with the chemical compounds that people do not want to breathe.

Leonie Cooper AM (Deputy Chair): There are two differences with Barcelona. One is that they have pedestrianised very many parts of the central area. Las Ramblas, which is the equivalent of Oxford Street, is completely pedestrianised. Secondly, they are much closer to the seacoast and the buildings seem to be slightly further apart and so there may be less of the canyon effect that we get in certain places. As far as I recall, there is not a big river that bisects the city that creates all the pinch points that we have in London with the river, the railway lines and all the other things that create queues of traffic here and there.

Peter McNaught (Director of Asset Operations, TfL): The other thing worth mentioning is that in our business plan this year we are investing £20 million of additional funds in some of our hottest lines like the Central line for temperature control. Also, I said that we had noticed a pattern that when it is hotter the particulate levels seem higher because we think the dryness allows the particulates to be freed up. We are hoping that that investment will not only bring the temperature down on those hot lines will possibly help the particulate levels as well.

Leonie Cooper AM (Deputy Chair): Which lines are the ones where you are doing the temperature control?

Peter McNaught (Director of Asset Operations, TfL): Central and Bakerloo lines.

Leonie Cooper AM (Deputy Chair): I can tell you that the Victoria and the Northern lines are pretty hot as well but, anyway, that is a different story.

Shaun Bailey AM: The Central line is hideously hot.

Leonie Cooper AM (Deputy Chair): We can have a fight over which is the hottest line as well as which one has the most dust, but we can save that for after the meeting is completed. Thank you very much. That is the end of my questions.

Caroline Russell AM (Chair): That brings us towards the end of our discussion. I just wanted to give you each a chance if there is anything that you felt you had not had a chance to say or if there is one thing that you really hope would change or shift. This is your moment.

Peter McNaught (Director of Asset Operations, TfL): Chair, I would like to thank you for inviting us here today and I would like to thank the Assembly Members for their questions and their interest in this subject. I have already said that we take the air quality of our customers and our employees seriously. Despite the fact that we have no evidence that the particulates on the Underground cause harm, we are not sitting around and resting on our laurels. We take it very seriously. We are working with our occupational health, our trade

unions and our colleagues across the business to try to bring these levels down and make a considerable improvement.

Rikard Moen (Head of Occupational Health, TfL): Once again, thank you, Chair and Committee. It has been a fantastic meeting. To echo that, the philosophy that we have in occupational health for this is - and this is really key - that one can never prove the absence of harm to people except by showing that no harm has occurred over a prolonged period. That is the next stage that we are going to with the epidemiology studies to make sure that we are not doing that because we cannot say, as the COMEAP report says, that categorically there is no harm until we have proven that. That research is very important.

Caroline Russell AM (Chair): Remind me. The epidemiological studies are coming out in a year's time?

Rikard Moen (Head of Occupational Health, TfL): No, we are doing a short-term one looking at sickness absence. That is to give us a feel. It requires two PhD students to work on it full-time. It is going to take two years. All our medical records are paper-based and so there is a lot of time to do that. That is going take two years, but we did not want to wait two years. That seemed a little bit too long and so we are doing a shorter study using sickness absence to see if there is anything striking within that. The definitive study will be there.

Caroline Russell AM (Chair): The sickness absence will be done when?

Rikard Moen (Head of Occupational Health, TfL): In the next three to six months.

Leonie Cooper AM (Deputy Chair): Again, is that something that we would be able to look at when it comes out?

Rikard Moen (Head of Occupational Health, TfL): Certainly, absolutely.

Professor Jenny Mindell (Department of Epidemiology and Public Health, University College London): The only thing is that if these various epidemiological and individual-based studies do give grounds for concern, any advice needs to be tempered by a comparative approach to make sure that people are not being scared off from going into the Tube and are instead doing something that is worse for their health.

Cat Cray (National Union of RMT Workers Stations Health and Safety Council Member): Thank you very much for inviting me. I echo what you said about comparators and peer-to-peer. I want to see that the scientific data we are collecting is consistent and that there is a rolling programme and it is not as patchwork as it has been. We have talked a little bit about being able to monitor daily across a long period of time to work out when we need to jump in on something.

Also, the Tube is not a balance sheet. It is a holistic system and we must not let money stop us from doing things. TfL has lost its central Government grant, which I believe was utterly wrong, but I do not want to see any effort on TfL's part or on the union's part asking for the collaboration of TfL to not happen because of money.

Caroline Russell AM (Chair): Thank you. My big takeaways are that we desperately need these epidemiological studies. I absolutely take Jenny and Cat's point about taking that comparative approach. I totally hear the problems about the money and I also welcome the measures that you are taking to try to clean up the Tube.