Dear Mr Birkett

TfL Ref: 2554-1314

Thank you for your email received by us on 24 March 2014 asking for information about why the Tunnel Cleaning Train for the London Underground network has been delayed. Please accept my apologies for the lateness in responding.

Your request has been considered in accordance with the requirements of the Environmental Information Regulations and our information access policy. I can confirm we hold some of the information you require. Due to the size of the size of the attachments, I will be sending a second email with 'Documentation 2' containing the remaining files. You asked for the following:

I wish to understand why the Tunnel Cleaning Train has been delayed. For example, what problems have so far been identified that have delayed its procurement, trial and/or operation e.g. the possible need for 'enabling works' and what is meant by this phrase? What reasons for the delay or briefings have been given to managers or Directors within TfL or others?

I can advise that there have been delays both due to supplier issues and emerging external issues, which are explained in greater detail accordingly.

Supplier issues:

The project strategy was to procure the tunnel cleaning capability as a "third party" deliverable, where the manufacturer is trusted to build and supply a machine to meet our requirements. As the project progressed it became clear that the hazards associated with the Tunnel Cleaning Unit (TCU) were not well controlled by the supplier, and this would require closer intervention from London Underground (LU). Greater engineering effort from within LU was dedicated to the project. This issue has resulted in extended timescales, as described in detail below.

The TCU supplier has struggled to meet our requirements for demonstrating that the machine will be safe and effective. This has delayed the design process. The Concept Design Review stage was conditionally passed six months late in May 2011, with over 100 engineering issues outstanding. By the time the Intermediate Design Review stage (intended to demonstrate that the emerging design meets the requirements of LU and will deliver the benefits we are seeking) was conditionally passed in October 2012 the project was a year late. 43 issues remained open, of which 13 were important issues remaining from the Concept Design stage (for example, an agreed design strategy for the Fire Detection system). By July 2013, the Final Design Review stage to "evaluate the final detailed design developed to meet the requirements of the Technical Specification", was 30% complete, but with a number of fundamental issues still open.

These issues include:

· A demonstration of the effectiveness of the filtration system. The filters proposed by the supplier are a mesh type, which are resistant to blocking and are self-cleaning, however, the disadvantage of the design is that the filter contains a high degree of variability in its manufacture and the supplier therefore cannot comprehensively demonstrate the filter's ability to capture fine particles. Without such a demonstration we would not be able to ensure that the air quality after cleaning will meet its requirements as per the technical specification (which was supplied in response to your previous FOI request dated 14 February 2013, reference FOI-1977-1213).

· An agreed design for the Fire Detection System. This is critical to LU as fires in tube tunnels have the potential to present a risk to customers and employees and could also cause damage that would suspend our services for an extended period. For the majority of trains and machinery our approach is to design-out sources of ignition and flammable substances. With the TCU this strategy is weakened, owing to the potentially flammable collection of dust and fluff in the machine, coupled with the very powerful (and therefore hot) components within the TCU, neither of which can be removed by design. This issue is further complicated by the presence of high air speeds, the airborne dust and the ambient heat within the TCU, which prevents any conventional fire system based on a smoke or heat detector from operating reliably. A solution has yet to be identified.

· An accurate and reliable laser system. The supplier's design concept provides effective cleaning by moving its cleaning heads close to the surface to be cleaned, thus delivering the maximum cleaning effect at the shortest range to its target. The cleaning heads are controlled by an obstacle detection system which uses a laser to survey the tunnel. During testing it was revealed that the laser system is not sufficiently accurate to detect the cables which we use for signalling. Demonstrations in the supplier's factory revealed that the machine would strike the cables, causing serious damage to the signalling system. When the machine was trialled again with the lasers disabled and the cleaning heads retracted, no meaningful cleaning effect could be achieved. A design solution has yet to be identified.

· An assurance that the power used is acceptable in the LU environment. The second way in which the TCU provides effective cleaning (in addition to the laser system) is by using a lot of power. Air movements, and the energy contained in the air flows, are fundamental to the concept. By imparting large amounts of energy via high pressure air the TCU forces the dust to become airborne. Once airborne, a relatively slow bulk vacuum flow captures the dirty air and routes it to the filters. Modelling showed that the TCU as designed would overheat within five minutes of starting up in the LU deep tube tunnel environment. The supplier has yet to produce a design which is able to offer effective cleaning within the available power limit.

· Other detail issues such as the structural integrity of the bogie frame, its derailment performance etc.

It should be noted that a range of suppliers were considered during the extensive pre-qualification and tendering processes. The selected supplier stood out on the grounds of the quality of their offering and their technical competence. LU stands by this assessment, and this has been validated by other metro railways such as Prague, Madrid and Beijing buying machines from the same supplier following competitive tenders. Those metros have a range of requirements of their machines which differ from LU's and none of them face as many constraints as the LU machine. Some of the metros have specified track bed cleaning only, others are able to operate more slowly due to lower constraints on their engineering hours access. Some of the machines have been specified only to clean litter rather than dust. Almost all of the other networks are understood to have larger, better ventilated tunnels which means that high levels of power can be used without corresponding increases in heat. Those metros which may have a problem with heat have

chosen to use diesel engines for their machines which are substantially more resistant to ambient heat than the electrical machinery that LU requires. Due to the constraints of the infrastructure a sufficiently powerful diesel engine cannot be used in the LU environment.

The only other potential supplier with a realistic proposal shared certain features with our previous tunnel cleaning machine. This was far less powerful, slower and was fundamentally inefficient at capturing the dust it disturbed. It was known to routinely release dust clouds, resulting in dirt and debris on LU's stations and air quality being degraded for a number of days following each cleaning run. This is a situation which would not be acceptable.

These issues were the cause of the delays between the initial planned date of 2012 and the later date of 2014. Note however that the current delays, leading to an estimate of 2017 are partially the result of emerging issues outside of the supplier's control.

Emerging issues leading to the enabling works.

The basic infrastructure of the London Underground was constructed over an extended period using a wide range of substances, all of which were in common use at the time, but some of which are now classified as hazardous for various reasons. During stakeholder consultations early in the design period, the project team identified that some materials, specifically those containing asbestos fibres (known collectively as "Asbestos Containing Materials or "ACM"s), could potentially become hazardous if disturbed by high pressure air.

It should also be noted that we undertake regular air sampling around the LU network and it is known that asbestos fibres do not become airborne during the routine operation of the railway – i.e. the asbestos assets are "safe unless disturbed". Monitoring has also shown that the air flows associated with new rolling stocks, while often disturbing dust, do not disturb asbestos fibres. It was however unclear if the TCU would disrupt the situation as the associated high-pressure focussed air flows are unlike anything which has been used in LU before (including the old tunnel cleaner which used a relatively slow-moving bulk flow of air). Assurances were therefore required to ensure that the new train would not create a greater problem than it would solve. In 2011, the project team set about seeking these assurances.

A working group was formed of all Duty Holders within London Underground, including the project team, hazardous materials specialists and senior engineering staff. To understand if the TCU was able to make asbestos fibres airborne a series of tests were designed using a high-pressure air rig and a vacuum setup which simulate the cleaning action of the TCU. These tests were performed under controlled conditions away from the operational railway, with the knowledge and understanding of the Health and Safety Executive.

These limited tests demonstrated that certain ACMs did release some fibres when exposed to the air flows used in the design of the TCU. In October 2012, with initial testing completed, a strategy document was issued (PVEC3052-BCV-STR-00001 - Asbestos Control Strategy for the Tunnel Cleaning Train). This stated that the TCU would operate only at air speeds which could be shown to be safe around ACMs, even if this compromised the cleaning capability.

Further testing was commissioned to understand at what point a high pressure air flow became able to disturb fibres from stable ACMs. The objective was to identify a flow rate which was able to produce beneficial cleaning while being guaranteed to avoid releasing fibres. Due to the complexity of dealing with ACMs and finding suitable test samples at viable test sites this work took over a year to conclude. A series of tests on every type of asbestos asset was carried out, leading to the conclusion that there is no point at which a directed air jet can be slowed to such a speed that it is guaranteed to avoid disturbing asbestos, yet be sufficiently high to perform useful cleaning.

This knowledge necessitated a change of approach which was agreed at the Project Board 26/06/2013 (minutes attached). In summary, the TCU would not be permitted to clean near ACM assets but would be allowed to clean at full power in locations where it was known that no ACMs are present. (An extract from minutes states that: The change to the strategy is as follows: Formerly the machine would be prohibited from some areas and clean everywhere else at a uniform, restricted, ACM-compliant limit. Now the TCT will clean at full power (non-ACM compliant) but will only do so where there are no ACMs of any type). This new strategy was to be coupled with limited removal of ACMs to clear areas of the track for operation. Efforts had already been made to map the presence of ACMs around the network, now investigations began into suitable controls to keep the machine away from those areas.

Following substantial investment in the network during the last ten years significant quantities of ACMs have been removed from the LU environment, however the remaining ACMs are spread over the entire network and cannot be readily detected by any automatic means. Given the risks associated with ACMs it is not viable to rely on train operators remembering when to turn the machine off when near an ACM area. The use of suitably rigorous procedural controls to keep the TCU away from ACMs reduced the area where the TCU could operate so far that the project costs substantially outweighed the benefits.

As the risks to the benefits became clearer a set of meetings were held, leading to a verbal presentation to the Rail and Underground Operational Meeting (RUOM) on 8 July 2013, after which a decision was made to minimise investment into the project while the ACM issue was resolved. As it became clear that there was no quick or clearly affordable resolution a decision was made to fully pause the project pending resolution of the ACM situation. A paper was submitted Rail and Underground Board (RUB) of Directors on 8 October 2013. The paper concluded that the benefits of the project were fundamentally undermined by the necessary restrictions due to the presence of ACMs, to the point that it was no longer worth investing in the machine. The paper was endorsed by RUB and the procurement of the TCU was formally paused.

With all other options exhausted the only remaining solution is to remove or encapsulate all ACMs on the LU railway. The decision was made, and endorsed at RUB on 19 December 2013 to initiate a separate project within the company's infrastructure programme to scope out and establish the cost of mitigation (via removal or encapsulation) of all ACMs on the LU railway, beginning with the track bed, which is where the majority of dust gathers.

A decision regarding the future of the Tunnel Cleaning Train project will be made once the cost and timescales associated with this ACM Mitigation project are known. The first phase of the work to price the mitigation of ACMs is underway now, with a report expected at the end of July 2014.

I would be interested in any information held by TfL relating to my requests e.g. reports, meeting notes, board papers or emails.

Attached is the following documentation:

Asbestos Working Group (AWG) minutes; unfortunately a set of notes is missing, which we believe is due to a meeting being cancelled due to non-attendance

Rail and Underground (RUB) board minutes, papers and presentations

Ballast sample maps

Rail and Underground Operational Meeting (RUOM) minutes

TCT RUB "pause" paper from October 2013 and the ACM enabling works funding paper from December 2013

June Project Board presentation "supporting evidence".

If this is not the information you are looking for, or if you are unable to access it for some reason, please do not hesitate to contact me.

Please see the attached information sheet for details of your right to appeal as well as information on copyright and what to do if you would like to re-use any of the information we have disclosed.

Yours sincerely

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