Quarts and Pint Pots – New ways to fit in

I want to first give you a brief introduction to the Heathrow terminal five passenger transit system

Heathrow T5 was designed in the late 1990's and the early noughties.

Construction began in 2002 and when in 2008 the terminal was opened on the 18th of March, an "as-built" description of the fire precautions and preventative measures was produced for the airport operator, then the BAA.

Unlike a traditional underground system, the terminal transit system is not a Metro nor is it anything like heavy rail. It is a track guided system using a centre rail to help steer the rail vehicles on their route and provide power.

The terminal transit system was designed to connect terminal 5A to terminal 5B and eventually would it join terminal 5C.

The principles of fire protection are enshrined within, first of all, the airport fire safety plan from which is derived the master fire safety plan for the terminals (in this case the whole campus of T5) - that then gives rise to the terminal fire safety plan.

The terminal fire safety plans include the physical measures required to meet the objectives of the master fire safety plan for the T5 campus.

There is another document that is worthy of mention and that is called the building fire safety plan.

This includes the maintenance and management plans and it is partnered by the operational fire safety plan in which the fire safety management for the premises is detailed

The TTS fire safety plan was produced as an addendum to the terminal fire safety plan.

Any significant change to any of the features of the airport terminal, or of the terminal transit should trigger an impact assessment of these changes on the BFSP/TFSP to preserve compliance with the AFSP.

Significant works require a fire strategy and a Construction Fire Safety Plan, at the end of which a fire risk assessment should be conducted pre-occupancy and if Regulation 38 applies, e.g. if the premises is a building, a whole host of important information should be recorded and provided to the Landlord (Operator) including the O&M manual.

If the premises are not subject to building regulations, then it has been customary at the airport for the Chief Engineers' requirements to set the ambitions for asset integration into the asset management plan (AMP).

The T5 TTS comprises running tunnels, three stations (one for each terminal 5AB and C), with platform edge screens and doors, safe walking routes along the entire length of the track and a maintenance facility at the T5 C end.

Really key to success is the management fire safety plan which details all the interfaces between the TTS and the airport terminal building

Special importance had to applied to the role of the operating staff – these were not specifically rail specialists at the time of build – they were multi-skilled airport customer service representatives.

It's also important to note that the RRO had not been fully enacted at the time of design and the '1989' sub-surface railway stations regulations were still in force under the Fire Precautions Act of 1971. These were impacted very heavily by the drafting of the RRO and were among the reasons why the Order suffered a rough journey in Parliament. (draw on P Wise remarks from his PRR)

The TTS was not a railway in the true sense of the word - no train operators for example, and unlike the DLR, no train captain and no station staff. This is therefore an "unattended" rail system.

It is the *unattended* or the *unstaffed* nature of this underground light rail system which dictated the use of British Standard 6853 Ia and the Railway Group Standard GM/RT2130, at the time of build and entry into service.

These documents contain only some of the essential elements of what is, nowadays, being recognised as a fire strategy:

These are:

- The reduction and method of keeping the risk of ignition low;
- A method of reducing or eliminating fire development;
- Important clauses on the material selection brackets internal and external);
- Fire separating elements for example fire barrier test specified by the duration of 20 minutes;
- an assessment of how a train vehicle will continue operate in case of fire. (Running Capability);
- The need for an operating and maintenance manual;
- specific measures are included for emergency lighting, for safety equipment and information provided to passengers and evacuation requirements.
- It's also vital to ensure that the fire performance of the rail vehicle does not degrade during maintenance and in ageing.

The impact of the Technical Standards for Interoperability has been regularly reviewed by the RSSB to ensure that the GM/RT are consistent with providing an acceptable level of safety in rail operations.

The GM/RT introduces an uncommon term "open points".

These are points which have not been effectively dealt with by the Technical Standards for Interoperability (TSI), for example, one really pressing open point is the use of Fire Control and Containment Systems (FCCS) as a substitute for fire separating elements in the design of rolling stock. Another had previously been the seat fire testing regime on which the UK had significantly different opinions to those of our (then) European partners.

It’s important to recognise that there is, today, an opportunity to reference the Common Safety Method and to realise that adherence to British Standard 6853 Ia itself does not protect the infrastructure in which the transit runs and this is the basis of the challenge faced when the airport decided to replace the existing rolling stock with new rolling stock which would also include longer train consists. Safety by Design is Goal Based.

A terminal fire safety plan / fire strategy can be produced along the lines of the principles of a classical fire strategy. Much debate exists among the aviation community regarding what comprises a terminal fire safety strategy or a building fire safety plan.

PAS 911 has not enjoyed a tremendous following or uptake, whereas BS 9997 – Fire Safety Management has had a smoother ride.

It’s for this very reason that a British Standard will be welcome for fire safety measures & operations at airports, just like the recently launched BS 9992 for rail.

Any changes to the rail vehicles needs to be assessed for impact on the TTS fire safety plan and therefore the terminal fire safety plan or building fire safety plan.

The way this can be done is to consider:

- First, Life safety, for legislative compliance;
- Second, property protection;
- Thirdly, business continuity;
- Fourth, insurance requirements, and
- Fifth, risk to reputation.

The need to capture all of these in the fire strategy is written in the Airport's ***Employer’s Requirements*** issued to all suppliers and binding upon all suppliers.

It is a pre-requisite that qualified and experienced fire safety professionals produce the fire strategy and define (e.g.) the level of fire detection and alarms, and produce the Cause & Effect Schedule.

Competency can be evidenced in many ways as exemplified by the kind of contributors to the recent British Standard 9992. It has been shown by the Grenfell Tower inquiry just how important is has been to keep a record of qualifications, experience and CPD. A number of automated record-keeping processes exist for this purpose and the UK CAA has found the Redkite system to have a demonstrable track record in this regard.

In the case of a fire strategy, it is simply not adequate to divide up life safety requirements and farm them out to (e.g.) the electrical engineer, mechanical engineer, human factors specialist, building management consultant etc.

It needs a persistent supervisory approach from a sector-competent fire engineer to assess the impact that the sum of all parts of an environment affording life safety in case of fire will have on the whole fire safety life cycle.

The sum of the parts will very often exceed the value of the whole.

Probabilistic fire safety does not often provide a suitable solution whereas Engineering first principles can. The fire engineer must assume that fire is an inevitability in the life cycle of a premises.

It's important to recognise that there is more than one approving entity - each one needs to be consulted and notified.

It may be, for example, the London Fire Brigade and the Office of Rail and Road (ORR), the DfT (who set the security requirements that airports must respect), the Landlord and the tenant (for example, the airlines have an interest) and the adjoining transport providers (e.g.) rail companies for heavy rail and perhaps London Underground for Metro.

Of particular challenge has been that fire safety by construction did not include compartmentation between the platforms and the terminal buildings as a whole and therefore could not be relied on and fire. Horizontal separation between stations along the track way is also not present allowing smoke and toxicity products of combustion to move freely along the routeway by air moment.

An effective solution relying on ventilation of smoke and toxic fumes has been important to increase time for evacuation and to assist because there are limited routes for access by the fire and rescue services.

Response is also, not instantaneous. It's important to recognise that in the UK the AFRS is not there for "so-called" domestic calls - their main purpose is to protect the aircraft.

The local authority fire services need to be escorted to the seat of the fire by the airport fire service or airport operations. This all adds time to the response objective.

Effective ventilation is vital to ensure sufficient time for evacuation and pressurisation of escape shafts remains key in supporting access for firefighters.

In cases where the AFRS are attending to an on-aerodrome incident, it might very often be the case that the local authority fire service might be the first to attend a fire call to a TTS and time is not on their side nor on the side of anyone escaping a fire.

It is therefore really important to limit fire spread and growth by using materials that have been wisely chosen and specified.

At the time of design, the type of rail vehicle chosen for the transit was a new design using Materials that were innovative and not fully elaborated. It was subsequently found that not all of the necessary testing had been complete before entry into service.

In today's design and build, extensive testing ***does*** have to be done and a Fire Certificate Inventory List (FCIL) is produced for all the significant parts of a rail vehicle.

This had not been the case in 2002

The rail vehicle comprised:

- a composite body shell
- seats
- vehicle interior and linings

- rubber tires
- rubber seals
- cabling

and of course, in the airport environment, passengers would be bringing on luggage.

Also, in this environment, maintenance would be done adjacent to the Terminal 5C station and it was important to consider that there might be a risk of hot works.

These were just some of the governing factors informing the design.

Another important factor was the fatal accident in Kaprun on 11 November 2000. The train, as the operating company's technical experts kept pointing out, was "fire-proof". Made of tough aluminium, it was able to transport 180 people up in one go, while the downward carriages would be carrying up to 180 people simultaneously. 155 people died in the fire - (150 on the ascending train, two on the descending train and three in the mountain station).

Although this was a different concept of vehicle from a different supplier, track transit vehicle specifiers were naturally cautious and a review of the *Kaprun* incident identified significant key factors common to the airport as there was no compartmentation or physical separation of the railway from different parts of the TTS and T5 buildings, and the absence of horizontal separation between the stations and the sections of the so-called lower level passenger walkways that lie directly below the stations.

In the original design of the terminal and the track transit stations there was no compartmentation between the platforms and the terminal buildings although there was a use made of that full-screen doors. There is no physical separation however on the guideway between stations the walkway and the maintenance facility with the exception of a roller shutter which does descend that has to have a gap to permit the continuous guideway.

For this reason, the passenger walkway tunnels are subdivided along their length by smoke doors and the performance of the ventilation system is a key determining factor for survivability.

The ventilation system must not be adversely affected by the design of the rail cars or changes in their design

Not only was the rail car to be changed but also an additional car was to be added and the frequency of the service was going to be increased.

This of course was all before the onset of Covid-19

The basis of design took a safety case approach - one that is familiar at airports – with an assessment made of the systems and each of its sub-systems, to ensure the target level of safety was at least as good as the current system and certainly no worse in future.

The maximum heat release rate was contractually required to be no more than that of the existing vehicles in their "as-built" condition, even though the selection of the fire properties of the materials had not been fully understood at the time of original design.

This was a huge hurdle to overcome and considerable negotiations took place many hours of discussion.

Why?

The reason being that the ventilation and exhaust provisions were governed by the fire strategy of Terminal 5C at the time of its design.

Toxicity limits hadn't been fully assessed by the manufacturer of the TTS in the early 2000's

I mentioned earlier how the Employer's Requirements and technical regulations described the airport's ambitions for safety in case of fire.

These were firmly written into a contract a total of nearly 700 clauses.

Toxicity limits hadn't been particularly well defined and it was obvious also from the list of vehicle major parts that the inclusion of rubber tyres would, in the event of an uncontrolled fire, lead to significant quantities of black smoke and toxic fume.

Specific heat release rates had been determined for a fire in the tunnel; a fire under the train in a station, and for a fire inside the train at the station (with the assumption that the windows would remain intact).

The inclusion of water mist suppression in the maintenance area allowed the heat release rate to be reduced to an equivalent of a sprinkler-controlled fire.

The objective was to limit the spread of smoke and toxic fumes for sufficient time to allow evacuation and protect firefighters in the event of them requiring access.

The UK Railway Safety Principals Guide 2b for stations and the USA NFPA 130 codes of practice informed the fire strategy.

It's vital to remember that the T5A building fire safety plan, whilst extensive, did not make special reference to the TTS.

The actual building fire safety plan only included 3 to 4 pages about the TTS in an otherwise 260-page document - that is to say, only 1 1/2% of its content - what would be the consequence of the impact of this 1 1/2% if left uncontrolled?

- Financial loss
- Loss of connections between terminals
- Missed flights
- Lost revenue
- Unwanted air navigation charges for delayed aircraft and
- Unwanted ground handling fees for delayed pushback, and more recently in Europe,
- The requirement for an airline to pay enhanced compensation for denied boarding of flights.

For any circumstances within the airport's control it was well worth the investment of time to get it right when procuring the new rail cars.

BS 6853 Ia was chosen in preference to the emerging European Norm EN45545 because the British Standard was considered more mature and robust whereas it was felt that the EN45545 allowed far too much of a relaxation of fire, smoke and toxic species properties.

The fire smoke and toxicity reaction to fire properties of the transit vehicle did not numerically meet BS 6853 Ia in two significant areas related to toxicity.

It was therefore considered that the departure from code be controlled by a concession based upon the heat release rate being kept as low as reasonably practicable (ALARP) and encouraging the manufacturer to source and use modern materials of limited surface spread of flame and low heat release rate.

A further condition of the concession was that any toxic species released as a consequence of an uncontrolled fire would have to be able to satisfactorily disperse and become diluted within the actual volume of the rail car and within the tunnel sections and station in a way that did not place increased demands on the existing ventilation systems.

Finally, but certainly not least important is the fire resistance of the floor fire barriers these had already exceeded the requirements of BS 6853 Ia and are likely to meet the more stringent requirements of NFPA 130 to be a BS 6853 Ia required a 20-minute fire resistant NFPA 130 requires 30 minutes fire resistance for the floor.

It's helpful to describe for a moment the influence of the use of intumescent in retarding the effects of the spread of flame and heat release.

These of course limit visibility and for that reason are not preferred in an enclosed underground environment.

To summarise, the carbody was expected to be a composite shell for which early indicative tests have been encouraging, and the internal and external materials will be chosen so that the spread of flame and the emission of toxic fume requirements will be met with the conditions applied in the concession - this will include decorative coatings. The fire performance of the rail car will be defined by a Chartered Fire Engineer and the train set placed into an environment where fire safety and security are strictly controlled.

The conclusion of this work, once complete, will be a more efficient and more frequent transit service, more happy passengers and less missed flights at least when air transport begins to pick up once again in future.

Thank you for your attention - if you have any questions please contact me using my email address at aajcash@yahoo.co.uk or by phone on + 44 7786790886.