Department for Transport

Science Advisory Council Position Statement

Hyperloop

Moving Britain Ahead

Overview

The Department for Transport's Science Advisory Council (SAC) met on 26 October 2016 and 14 June 2017 to discuss Hyperloop technology.

The SAC considered the technical feasibility of Hyperloop and how this technology could be utilised in Britain's future transport infrastructure. The Council also considered how the UK's science, engineering and advanced manufacturing capabilities could support the development and delivery of Hyperloop technology.

Background

Hyperloop was first proposed in a 2013 paper by the American entrepreneur Elon Musk, which outlined a tube-based system where pods transported passengers or freight at very high speeds in a low friction environment.

A number of organisations are currently working to develop and commercialise this technology. The technical aspects of each proposal vary; however the key elements of each system include:

- A tube containing a low pressure, controlled environment;
- Sealed pods carrying freight or passengers; and
- A system for levitating and accelerating pods inside the tube.

The anticipated end result is a high speed transport system that, compared to conventional planes, trains or cars, is also very energy efficient because of the lack of air resistance and rolling resistance.

One of the organisations working to commercialise this technology, Hyperloop One, delivered a presentation to the SAC. However, this paper does not evaluate the proposals of any specific Hyperloop developer, but rather assesses the concept as a whole.

During the meeting, the SAC considered:

- The technical feasibility of Hyperloop technology;
- The benefits and challenges of building Hyperloop infrastructure in the UK; and
- The opportunities for the UK engineering sector and supply chain to support the development and delivery of Hyperloop technology.

Technical feasibility

The SAC recognises that the fundamental elements of Hyperloop are based on established technology including: maglev propulsion, linear induction motors, vacuum pumps and autonomous vehicle control systems. The SAC considers that enabling these elements to work together in a controlled manner at very high speed is the core technical challenge around the successful development and implementation of Hyperloop systems.

The SAC recognises that, whilst there are some specific design and operational challenges to be overcome, there is nothing in the fundamental Hyperloop concept that would prevent it from being able to operate safely and securely. However, because of the scale of the technical challenges involved (assuming that these are ultimately resolved and that the technology proves acceptable to passengers), an operational Hyperloop system is likely to be at least a couple of decades away.

Technical challenges

Hyperloop systems are intended to operate at very high speeds, with short headways - potentially with headways of as little as 10 seconds between pods – in a sealed, low pressure environment. This challenging environment introduces a range of risks that will require careful consideration in the design and operation of Hyperloop systems. Examples include, emergency braking at very high speeds, power failure, protection from physical and cyber-attack and the protection and evacuation of passengers in case of a depressurised tube or pod.

The topology of the UK, its dense population and intensive land use may make Hyperloop construction more difficult and costly than in other locations. As an example, it may prove challenging to find a suitable alignment above ground for a Hyperloop system to enable it to operate at high speeds (requiring shallow gradients and curvature to limit “g” forces on passengers) without impacting on existing infrastructure or protected areas. This may necessitate full or partial underground construction, which would have a significant impact on capital costs and would make maintenance and emergency evacuation more difficult. There may also be significant challenges in tunnelling in parts of the UK depending on the local geological conditions.

Although not a technical issue, the SAC recognises that the radical nature of Hyperloop may raise some issues around passenger acceptance. This is not unique to Hyperloop as similar debates happened following the development of rail systems in the 19th century and aeroplanes in the 20th. But it will be critical for the success of the systems to demonstrate to passengers that Hyperloop systems will operate with the highest levels of safety and reliability. Similarly it will be important to ensure that passengers do not feel unduly confined within passenger pods and do not experience excessive or uncomfortable g-forces.

The SAC notes that, because of its unique design and operational characteristics, Hyperloop systems would likely require a new regulatory framework and associated safety standards.

Potential benefits of Hyperloop for the UK

The SAC recognises that a UK Hyperloop network has the potential to stimulate economic development across the country by substantially reducing journey times. Indeed, stated maximum speeds of around 700 mph correspond to travel times of less an hour between most UK destinations. This could have a transformational impact, for example allowing commuters to live anywhere within the country and easily commute great distances. It would also provide a means of connecting separate towns and cities to deliver agglomeration benefits.

UK capability for developing and delivering Hyperloop systems

The SAC believes that the United Kingdom has a significant level of relevant expertise and experience from its strong academic and industry base to support the worldwide development and delivery of Hyperloop systems. This includes expertise in the following areas:

- autonomous vehicles;
- aerodynamics;
- control systems;
- energy management systems;
- advanced materials;
- tunnelling;
- design and delivery of major civil engineering projects;
- whole-life asset management; and,
- project finance and professional services including legal, financial, architectural and engineering

Conclusions

The SAC recognises the potentially transformative impact that Hyperloop systems could have on passenger and freight transport in UK and around the world.

The SAC notes that the fundamental elements of Hyperloop are based on established technologies but that there remain significant engineering challenges in enabling these elements to work together in a safe and effective system.

Proof of concept demonstrations are planned over the next twelve months by a number of Hyperloop developers. If successful, these will help to demonstrate that the concept is feasible from a whole-system perspective.

After initial demonstrations have shown that the core elements of Hyperloop technology have been successfully integrated, the SAC believes that British engineering expertise supported by our strong professional services and infrastructure delivery sectors could play an important role in developing and commercialising the technology.

The SAC will continue to review the progress of Hyperloop and may make specific proposals to the Department. In the meantime we recommend that the Department:

- continues to monitor the development of Hyperloop technology;
- notes the capability of the UK to support the design, development and delivery of Hyperloop technologies; and,
- remains in contact with BEIS, Innovate UK and regional bodies as consortia explore the potential applications of Hyperloop as a transport mode within the UK.

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