



Comments of Virgin Hyperloop One
to the
United States Department of Transportation,
Office of the Secretary
Docket No. DOT-OST-2019-0165
Request for Comments on Non-Traditional and Emerging
Transportation Technology (NETT) Council

January 8, 2020

Virgin Hyperloop One commends the United States Department of Transportation (USDOT) for moving quickly to invite comment on matters considered through USDOT’s Non-Traditional and Emerging Transportation Technology (NETT) Council, including hyperloop transportation.

Introduction and Overview

Virgin Hyperloop One (“VHO,” “we” or “our”), a U.S. company based in Los Angeles, has developed a working full-scale system prototype of the VHO Hyperloop System in Nevada. With over 200 employees, and having raised over \$400 million in private capital, VHO is driving hyperloop technology development and commercial projects as well as safety, regulatory and standards initiatives for hyperloop globally.

In this docket, VHO provides comments both generally and in response to specific questions.¹ We begin by presenting our recommendations and related justification for how and why USDOT should act to facilitate the development of safe hyperloop transportation. We then address specific questions posed by USDOT.

We emphasize at the outset that:

- (1) The time to move forward with hyperloop transportation is now; and
- (2) It is critically important that USDOT move expeditiously to provide clarity as to how it will regulate hyperloop transportation.

The Time to Move Forward with Hyperloop Transportation is Now

Interest in hyperloop as a mode of transportation is growing as its benefits are more widely understood. There is strong and increasing interest in several states and from regional authorities and transportation groups across the U.S in hosting facilities for hyperloop testing and/or revenue service (e.g., Ohio, Missouri, Texas, North Carolina, South Dakota, North Dakota, Washington, Tennessee, Delaware, Georgia, New Mexico and West Virginia). There is significant interest outside of the U.S. as well – in the Gulf region, in India, and in Europe.

People, businesses and transportation leaders want new solutions to reduce congestion and address mobility challenges for passengers and freight. Furthermore, the great speed achieved through hyperloop service can do more than mitigate today’s transportation challenges; it can transform transportation to increase economic opportunities and bring communities and regions together. Trips that take hours today will take minutes, providing businesses access to greater labor and consumer

¹ See 84 Federal Register 65214 *et seq.* (November 26, 2019).

markets, providing individuals and families a wider range of opportunities for employment and living, and generally opening up new opportunities for all.

The birth of an extremely safe, environmentally sustainable, energy efficient and extremely fast means of transport holds the promise of boosting economic growth for the United States as a whole. It spurs the development of a new high technology industry, leading to significant economic benefits and new jobs in manufacturing, construction, engineering, and other industries. These are jobs for the present and the future, supporting not just deployment of hyperloops in the United States, but also the export of American products to other countries that build hyperloop transportation networks.

The hyperloop supply chain requires a cross-industry development and manufacturing base – auto, rail, aviation, aerospace, construction, hardware and software. VHO is applying know-how from bridges, highways, airplanes, and other industries to the development of hyperloop structures, pods and operating systems. In this way, hyperloop can support not only new industries, but also provide existing industries with a new application and market for their hard-earned expertise.

Prompt Action to Clarify How Hyperloops will be Regulated is Essential and Will Provide Benefits

Clarity from USDOT on regulatory approach, procedures, timelines and, ultimately, requirements is essential to facilitate rapid development and deployment of safe hyperloop transportation. Clarity would allow the hyperloop industry to move forward more rapidly, as there would be a better understanding of needed equipment, systems, and operations. Clarity will also help attract non-federal investment in this new transportation mode, whether from state and local governments, private investors or transportation industry strategic partners. It is also important that regulatory clarity be provided promptly so that the nation can receive the benefits of hyperloop transportation and its wider economic impacts immediately

However, not just any clarity will do. The regulatory regime for hyperloop transportation should be modern, including a performance-based approach, as is appropriate for a modern, high-technology transportation mode. Further, with regulatory clarity, VHO, its various stakeholders, and the industry can more rapidly aggregate the financial resources necessary to bring hyperloop technology to full reality, including to operational testing and, ultimately, the commencement of revenue service.

We suggest hyperloop be regulated, in a modern way, within the rail safety statutory framework and, for certain short routes, as transit. Regulation of hyperloops should be modern, flexible and performance-based, not through prescriptive details as to equipment or process.

Hyperloops will be safe by design. There will be no at grade crossings and the tube protects against any pod (vehicle) leaving the fixed guideway. Hyperloop projects should be eligible for federal transportation, new technology, and other funds, apportioned or discretionary, to the same extent rail, maglev, or rail transit are eligible.

The sooner that USDOT can advise the industry and the public how it will regulate hyperloop transportation, the sooner hyperloops can be developed and deployed – and the sooner the public will receive the many transportation, economic and safety benefits of hyperloop transportation.

We were pleased to learn that congressional transportation leaders recently wrote to Secretary Chao regarding new transportation technologies with a similar message: “Businesses cannot innovate if the regulatory frameworks in place are unworkable for prompt and safe testing and implementation of new technology, particularly if such innovations could lead to changes that improve the safety and efficiency of travel for people and goods.”² Safety, prompt implementation and a modern regulatory approach compatible with new technology are welcome policy directions. VHO is eager to cooperate with USDOT to those ends, so that deployment of the safe VHO Hyperloop System can occur as soon as possible.

Discussion

We turn now to a fuller presentation of our regulatory recommendations and of the reasons USDOT should work expeditiously to advance hyperloop transportation.³

² Letter of December 9, 2019 to Secretary Chao from: Senator Roger Wicker, Chairman, Committee on Commerce, Science, and Transportation; Senator Maria Cantwell, Ranking Member, Committee on Commerce, Science, and Transportation; Rep. Peter DeFazio, Chairman, Committee on Transportation and Infrastructure; and Rep. Sam Graves, Ranking Member, Committee on Transportation and Infrastructure.

³ Before going further, we briefly describe “hyperloop transportation.” It could be defined as --

“(1) fixed route ground transportation of passengers, freight, or both;

“(2) through an enclosure that maintains a very low air pressure environment;

“(3) designed to reach speeds above 310 miles per hour when traveling between points not in the same metropolitan area;

“(4) physically not connected to the general railroad system of transportation and free of at grade crossings with any mode of transportation;

“(5) which uses (A) magnetic levitation; or (B) an alternate means approved by the Secretary of Transportation that is not steel or other metal wheels on rail track;

“(6) which uses (A) electro-magnetic propulsion; or (B) an alternate means of propulsion approved by the Secretary as a form of propulsion for hyperloop transportation; and

“(7) which moves individual vehicles through the enclosure (A) autonomously, provided that vehicle command and control functions are subject to human supervision from outside the vehicle and, if required, human intervention from outside the vehicle; or (B) by other means approved by the Secretary.”

In the above definition, the 310 miles per hour (approximately 500 kilometers per hour) reference is from ongoing international discussions, but VHO envisions its hyperloop transportation system reaching speeds over 600 mph in intercity service. When used in service within a metropolitan area (i.e., transit or commuter service), operating speeds are expected to be lower due to shorter trip lengths. Hyperloop facilities would not be physically connected to the general system of rail transportation, though the same station could be a point of destination or departure for hyperloop service and other service.

Multiple Pathways Appear to be Available under Current Law; USDOT Should Promptly Confirm the Regulatory Path(s) Forward, so Hyperloop Transportation Can Proceed

Clarity from USDOT on how it will undertake safety regulation of hyperloop transportation will make a tremendous difference in advancing the public interest, particularly if it can be provided expeditiously.

With clarity on the framework for regulatory approval, VHO and its various stakeholders can better rally the financial and other resources necessary to bring hyperloop technology to full reality and deliver the next mode of transportation across the U.S. and abroad. This will serve the public interest in faster, improved, safe, environmentally friendly and more efficient transportation – and the sooner the regulatory clarity is provided, the sooner the public will benefit.

State and local governments and private firms have choices for deploying their funds. The goals of USDOT have been to attract non-federal investment to transportation and to advance technology in transportation. Uncertainty as to the regulatory treatment of hyperloop transportation can result in those non-federal funds being invested in non-transformative projects and systems. But, swift action by USDOT setting forth a framework for hyperloop transportation safety regulation would go far to unlock private and other non-Federal investment in this transformative technology.

Elements of regulatory clarity would include identification of a regulatory approach and, ultimately, requirements, as well as related information on timelines and process. Collectively, what is needed is a path forward, under present law, to operational testing and, ultimately, the commencement of revenue service by hyperloop. We consider that such a path is available under present law.

VHO's Hyperloop System is widely applicable. The same system can provide transit, commuter operations, and very high-speed intercity transportation. This ability to scale across a spectrum of transportation uses has dramatic benefits. However, this also means that the hyperloop could be covered by multiple authorities and rules, with some risk of conflicting rules.

VHO considers U.S. law as allowing VHO to proceed concurrently on two safety regulatory models of prime interest. One would be a transit approach covering certain short routes that is led by the states consistent with FTA's national transit safety plan. The other would be a rail approach led by the FRA for any short routes that would be subject only to rail regulation and for longer intercity routes. VHO sees merit in and potential application of both models.

Transit Regulatory Path. VHO is interested in moving forward with hyperloop service on a number of short routes, which would be in the nature of transit applications, and thus, a state-based regulatory approach. A hyperloop service of relatively short length readily should be considered a fixed guideway transit service subject to regulation by a State Safety Oversight agency (SSO) within the meaning of 49 USC 5329.⁴ VHO sees merit in this approach for several reasons.

First, a hyperloop project of short length for transit could be built more rapidly and at lower cost than longer hyperloop routes. As a result, early hyperloop projects and early governmental decisions regarding safety of hyperloop service could be in the context of transit service.

Second, under 49 USC 20102(2), “rapid transit operations in an urban area that are not connected to the general railroad system of transportation” are not railroads subject to regulation under the rail safety regulatory regime. Combined with 49 USC 5329, the statute envisions transit regulation under a state-based approach. So, while the particular facts will always be a consideration, safety regulation pursuant to the federal transit safety statute is clearly a possible outcome for safety regulation of a short length hyperloop project. The FRA itself has come to the conclusion that some short routes of “rail” service could be subject to regulation as rail and others as transit, depending on particulars.⁵

Third, an individual transit agency (and/or the SSO for its state) potentially could move relatively quickly in effectuating a hyperloop safety regulatory regime, such as by requiring compliance with appropriate industry or international standards.

In such case, USDOT would have the opportunity to accept state and any local regulation as a path to enabling prompt implementation of a safe and innovative mode of transport that provides transportation, economic growth and other benefits. Moreover, USDOT would benefit from the experience at the state and local level in crafting federal rules for hyperloop service.

In the event that a project or type of project may not be readily classed by USDOT or its operating agencies as transit or rail for safety regulatory purposes, the Office of the Secretary must ensure that any such jurisdictional uncertainty as between two USDOT authorities is resolved in a timely manner, and in a way that is consistent with prompt as well as safe deployment of hyperloop transportation. Any approach to such a situation that does not resolve the jurisdictional issue rapidly could create financial and other uncertainty for implementation of worthy and important projects, something we are confident USDOT does not want. The approach also should allow the project proponent to present its views as part of the decision-making process.

⁴ See subsection 5329(e) regarding State Safety Oversight programs for rail fixed guideway public transportation systems. Other material in Section 5329 includes provision for the national public transportation plan, 49 USC 5329(b).

⁵ See 49 CFR 209, Appendix A, which presents an explanation of FRA’s safety jurisdiction, particularly the discussion at the following subheads: “Urban Rapid Transit Operations”; “Rapid Transit Connections Not Sufficient to Trigger FRA’s Exercise of Jurisdiction”; and “Coordination of the FRA and FTA Programs.”

Rail Regulatory Path. VHO intends that hyperloop services also will include commuter applications and longer distance services apparently subject to federal rail safety regulation under current law.

In 2018, the Federal Railroad Administration (FRA) finalized certain rules regarding high-speed passenger rail (HSR).⁶ Those rules concern equipment for operations at up to 220 mph, with shared track use allowed for speeds at 125 mph or less.

In that notice of final rule, the FRA explained that a significant complication in developing the rule was to arrange for high-speed passenger train service, at up to 220 mph, to be able to share track with other services at speeds of 125 mph or less. FRA also made a further comment on higher speed operations not utilizing the general rail system:

“[FRA] continues to believe that addressing proposals for standalone HSR systems on a case-by-case basis and comprehensively (such as through a rule of particular applicability or other specific regulatory action(s)) is prudent.”⁷

FRA also stated that, to some extent, it had utilized performance-based regulation in that final rule.⁸ As to hyperloop transportation, it will differ to an even greater degree from conventional passenger rail than does 220 mph high-speed passenger rail. This circumstance is particularly well suited for a comprehensive and performance-based approach.

Hyperloop transportation is structured as a separate system that does not implicate the safety risks of at grade crossings or shared track. Further, the pod (vehicle) travels inside a tube, an isolated, controlled environment, so the pod cannot leave the fixed guideway. This is a similar but additional safety benefit that warrants recognition in developing the regulatory approach. The vast technological differences between a standalone hyperloop and a conventional U.S. railroad (freight or passenger) enable USDOT to develop performance-based regulation for a stand-alone hyperloop system.

As to the applicability of the rail safety statutory regime, we note that the definition of “railroad” for purposes of the rail safety statute includes “any form of nonhighway ground transportation that runs on rails or electromagnetic guideways,” including “high speed ground transportation systems that connect metropolitan areas, without regard to whether those systems use new technologies not associated with traditional railroads.” 49 USC 20102(2).⁹

⁶ See 83 Federal Register 59182 *et seq.* (November 21, 2018).

⁷ *Id.* at 59186.

⁸ *Id.* at 59189.

⁹ FRA has made a broad statement of its jurisdiction in this regard: “intercity passenger operations that are not standard gage (such as magnetic levitation system) are within FRA’s jurisdiction even though not part of the general system.” 49 CFR 209, Appendix A, subhead “Intercity Passenger Operations.”

Further, the current rail regulatory system has the merit of including provision for waivers, rules of particular applicability and other flexible features. Such flexibility in the safety regulatory regime for hyperloop transportation would be a positive and would help advance safety. Certainly, hyperloop should not be regulated as a traditional rail system with steel wheels on steel rails, locomotives and engineers, and other equipment and operational elements not applicable to hyperloop transportation. So, flexibility, including the opportunity for waivers and rules of particular applicability, are a positive in any regulatory regime for hyperloop transportation.

Also, as is appropriate for longer distance service in interstate transportation, outside of the transit context discussed above, rail safety regulation preempts state and local law, to avert a diversity of regulatory regimes, and potentially conflicting regimes, on a single trip.

So, we see a rail and transit regulatory approach as a path clearly available to USDOT for safety regulation of hyperloop transportation.¹⁰

Modern, Flexible, Performance-Based Safety Regulation is Appropriate for Hyperloop Transportation

As a new technology, hyperloops should be evaluated and regulated with a modern approach. By design, the hyperloop operates as a separate system. It is not physically part of the general rail system or of an existing transit system (though hyperloop terminals or “portals” can be integrated with stations for other modes or systems).¹¹ The hyperloop’s separate structure and attributes (e.g., no at grade crossings, no shared track with other vehicles, no physical interaction with different modes, operation within a controlled environment) reduce hazards and promote safety.

Regulating hyperloop transportation under modern, flexible, performance-based rules (and/or guidance) facilitates continued innovation and adaptation, an approach that will serve the public interest. For example, under a performance-based rule, incremental improvements to update and modernize technology can and should be allowed without having to go through the potentially complex and time-consuming process of changing a rule. In contrast, older design-based approaches can trap a regulated entity and the regulator in obsolete technology unless a rule is changed (and then it might have to be changed again).

¹⁰ In the event that USDOT should take some other approach to safety regulation of hyperloop transportation, what would be important is that such other approach be operable under current law, clear, workable, flexible, and arrived at promptly. As noted above, clarity and expeditious action will facilitate investment in, development, and deployment of a new mode of transportation, hyperloop service, that promises tremendous public benefits. It will also mean that the benefits are experienced sooner.

¹¹ FRA has noted that operations that are not standard gage are not part of the general system of rail transportation, even though they may be within FRA’s authority under 49 USC 20102(2). See footnote 9, *infra*.

More specifically, a performance-based approach could state that a relevant equipment or operating system governed by a rule could be changed without changing the rule, subject to some parameters, such as notice and review of the change by USDOT for potentially material changes. So, a performance-based rule can and should have flexibility built into it to allow for certain updates and should not have to be lengthy, very detailed or complicated. Moreover, the agency retains oversight authority over the flexible, performance-based safety rules and compliance with them.

In short, the hyperloop represents the kind of major break from current and past technology that justifies using a modern, performance-based approach to regulation that would be streamlined but safe. Safety would be the object of the rules and the rules would be validated by appropriate simulations, operational testing, and any required route-specific testing before commercial operation.

FRA has recognized the advantages of a standalone system, notably that it “can optimize its operations to high levels of performance without necessarily having to adhere to requirements generally applicable to railroad systems in the U.S.”¹² If rail statutes are to be a basis for safety regulation of some hyperloop services, the standalone nature of the VHO system and its positive qualities present the opportunity to swiftly achieve innovation, economic development and other benefits through modern, performance-based regulation.

Use of Independent Safety Assessments and Reviews

VHO’s peerless commitment to safety includes reviews of equipment, physical and hardware and software operating systems and processes developed by our world class engineering team and subject to further review by a separate team of experts in the company and by an independent safety assessor (ISA). We believe this approach, particularly the use of an ISA, merits substantial recognition in a safety rule towards achieving compliance with applicable safety requirements and authorization to undertake commercial operation of a hyperloop. Particularly if there is a prospect that regulatory agencies would not be as deeply staffed as they would like, finding a skillful way to make use of highly qualified independent reviewers, accepted by the regulatory agency, would be a positive feature of a performance-based regulatory system, allowing merited approvals to be achieved perhaps more expeditiously but very responsibly.

Provide for Hyperloop Funding and Program Eligibilities in Line with those for Rail, Rail Transit, and Maglev

Deployment of the hyperloop technology can be facilitated by USDOT interpreting that hyperloop transportation is eligible for certain funding programs.

¹² 83 [Federal Register](#) at 59186 (November 21, 2018).

Given the apparent applicability of rail and transit safety statutes to hyperloop as outlined above, investment in the hyperloop transportation mode should be found by USDOT to be eligible under USDOT programs to the same extent as rail, maglev, or rail transit investments -- whether the eligibility is under title 23 (highway) or title 49 (transit and rail) programs, whether the particular program is apportioned or otherwise, whether it is for discretionary grants (including for testing facilities), for loans or other types of credit assistance, or otherwise. Hyperloop transportation also should be considered an eligible use of funds under USDOT programs to reduce congestion or emissions or to invest in research or new transportation technology.

As the hyperloop technology (at least the VHO Hyperloop System) uses a very recently developed form of magnetic levitation, USDOT should find hyperloops eligible for the same treatment accorded maglev and high-speed rail in terms of access to highway rights-of-way, subject to safety, under section 142(f) of title 23.

More generally, should USDOT agree with VHO's suggested rail and transit regulatory framework, follow-up action would be appropriate to integrate reference to hyperloop transportation into FRA and FTA rules with respect to eligibility for program funds.

Environmental Review

Due to the significance of hyperloop transportation as a transformative means of transport, it would represent sound policy for USDOT to support expeditious completion of the environmental review process for any hyperloop project subject to such review, so that the public could receive the benefit of the new technology as soon as practicable.

In addition, the VHO Hyperloop System is environmentally friendly and any review should be able to be concluded promptly and favorably. For example, the VHO Hyperloop System has zero direct emissions and will produce minimal noise. The low air pressure in the tube reduces energy consumption compared to other modes. The structure and tube are narrow and require less right-of-way than other transportation options, meaning impact on less land and the resulting less impact on land uses, including by plants and animals. It will reduce the need to build additional lanes of highway, thereby mitigating adverse impacts from other activity. These and other considerations warrant swift completion of any environmental review.

Moreover, in the context of project environmental review, USDOT has wisely championed the approach of undertaking required reviews concurrently rather than sequentially. Similarly, review of any safety regulatory issues concerning the VHO Hyperloop System can take place before or concurrently with any environmental review of specific routes.

Support for the NETT Council and its Role

Before turning to the specific questions, VHO also notes its agreement with the premise underlying creation of the NETT Council. Those involved with non-traditional and emerging transportation technologies, such as hyperloop transportation, should have the ability to approach the Office of the Secretary so that any regulatory gaps and other non-routine issues can be addressed in a timely manner. The NETT Council appears to us to be well-suited for these tasks. What is important, however, is for USDOT to address such issues quickly, so that the U.S. promptly benefits from new and emerging transportation technologies, particularly including hyperloop transportation.

Specific Questions

While VHO's principal points are set forth above, the [Federal Register](#) notice in this docket also posed specific questions, reproduced and addressed here.

1. Are there existing Federal transportation laws or regulations that inhibit innovation by creating barriers to testing, certifying or verifying compliance, or operating non-traditional and emerging transportation technologies? Please provide specific examples, explain why the requirement imposes a barrier, and identify the specific law or regulation that you believe should be changed and describe how it should be changed. Please identify all associated regulations that should be changed, including specific citations to the Code of Federal Regulations and explain the need for the change.

Reply: As discussed above in our presentation of principal points, VHO's Hyperloop System is a fixed guideway system but it is not traditional rail transportation with wheels on ribbons of steel and VHO certainly does not use "standard gage" track. The VHO Hyperloop System involves magnetic levitation within a very low-pressure tube, using "pods" to carry passengers and/or freight, and sophisticated command and control systems. It is not physically connected with the general system of rail transportation.

In explaining the scope of its safety jurisdiction in Appendix A to 49 CFR 209, FRA states that "intercity passenger operations that are not standard gage (such as magnetic levitation systems) are within FRA's jurisdiction even though not part of the general system."

However, the vast majority of FRA's safety rules are drafted for the general system of rail transportation, specifically worded to apply to "standard gage" rail operations.

This includes but is not limited to rules for –

- track standards (49 CFR 213);
- freight car safety standards (49 CFR 215);
- railroad operating rules (49 CFR 218);
- rear end of train markings (49 CFR 221);
- safety glazing standards (49 CFR 223);
- locomotive safety standards (49 CFR 229);
- safety appliance standards (49 CFR 231); and
- braking systems (49 CFR 232).

The vast differences between the VHO hyperloop system and a standard gage railroad leads to the conclusion that VHO would be exempt from the many FRA rules drafted as applicable to standard gage. We think that inapplicability is appropriate.

Yet, FRA’s statement in 49 CFR 209, Appendix A, claiming jurisdiction over magnetic levitation transportation, leaves uncertainty as to how that jurisdiction would be exercised (if USDOT confirms that jurisdiction through the NETT Council or otherwise).

Theoretically, USDOT/FRA could extend to hyperloop the safety rules applicable to standard gage operations. But, under such an approach the hyperloop technology, its unique on-demand operational model, and its high speeds would be frustrated. The VHO hyperloop guideway, vehicle, motive power, braking systems, etc. are all radically different from the physical systems of tracks, locomotives and brakes described in the FRA’s rules. Efforts to take action to repair or adjust equipment, conduct inspections, file reports, etc. geared to the non-hyperloop technology would seem unworkable as well as potentially burdensome and costly.

FRA itself has recognized that to some extent distinct rules are needed to facilitate “high-speed” rail:

“[FRA] continues to believe that addressing proposals for standalone HSR systems on a case-by-case basis and comprehensively (such as through a rule of particular applicability or other specific regulatory action(s)) is prudent.”¹³

To date, FRA has established rules concerning rail operations up to 220 miles per hour. VHO envisions intercity hyperloop transportation at speeds over 600 miles per hour and international discussion of hyperloop would define it as involving design speeds of at least 310 miles per hour. Such qualitatively higher speeds reinforce the idea advanced by FRA in that 2018 Federal Register notice that high speeds should be addressed separately.

¹³ 83 Federal Register at 59186.

We see that approach as allowing for USDOT regulation of hyperloop safety in a modern, performance-based manner. There should be no effort to burden a hyperloop company with rules developed for standard gage track. Rules such as those listed above would be unworkable and burdensome should they be applied to VHO operations.

However, whether –

- (1) a given safety rule developed for standard gage operations is to be applied to VHO's hyperloop system, which likely would result in a request for a rule of particular applicability or other form of waiver, to avoid unworkable requirements; or
- (2) the rules are not applicable and VHO must work with FRA/USDOT from a relatively clean slate as to how jurisdiction might be exercised with respect to hyperloop safety,

a performance-based approach to rules or guidance is the proper response in the context of hyperloop, a cutting edge and evolving technology.

We want to make clear that this reply, by highlighting the inapplicability of current rail safety rules to hyperloop, does not weaken our strong safety commitment. However, applicable broad safety concepts embodied in the FRA's rules would have to be adapted to hyperloop transportation. For example, while rules for the brakes on wheeled locomotives and cars should not be applicable to VHO's system, the regulatory system for hyperloop transportation should address the braking function -- the system's ability to slow and stop a pod traveling in a hyperloop tube. Similarly, while the VHO pod will not share track with non-VHO vehicles and faces no at grade crossings, aspects of positive train control not addressing at grade crossings (such as avoiding rear end collisions) can be adapted and continued.

So, many specifics of FRA rules would be burdensome or unworkable if applied to hyperloop, including but not limited to those listed above, written to cover standard gage operators. Yet, VHO is strongly committed to safety, and looks forward to working with USDOT to adapting key safety concepts into a performance-based regulatory approach to hyperloop.

2. Are there existing design or performance requirements that may contribute to a reduced safety purpose or impose more cost or restriction on the design of non-traditional and emerging transportation technologies than is warranted?

Reply: As this question is worded, it appears to ask whether a performance-based requirement, as well as a design or other specific requirement, could be costly or burdensome as well as not contributing to safety performance. We noted earlier benefits of the flexibility that can be part of performance-based rules. For example, under a performance-based rule, incremental improvements to update and modernize equipment or a process or a system can and should be allowed, within parameters, without

having to go through the potentially complex and time-consuming process of changing a rule. In contrast, older design-based approaches can trap a regulated entity and the regulator in obsolete technology unless a rule is changed (and then it might have to be changed again later).

However, when a topic is truly not applicable, a performance-based rule as well as a specific design or process rule is a burden. For example, VHO's hyperloop system does not include any at grade crossings. So, requirements regarding at grade rail-highway crossings would be burdensome, whether constructed as performance-based or in detail because of the absence of at grade crossings in the hyperloop system.

In short, performance-based rules are more flexible and appropriate for innovative technology than specific design, equipment or process rules. They allow prompt implementation of improvements. But even a performance-based rule can be a burden or needless cost to the extent the substance of the rule is inapplicable.

3. If you identified a barrier to innovation in response to Question 1 or 2, above, can this barrier be removed or mitigated without resorting to additional rulemaking? If rulemaking is necessary, please identify all associated regulations that should be changed, including specific citations to the Code of Federal Regulations and explain the need for the change and how safety will not adversely be impacted.

Reply: We see potential for addressing a number of our concerns without rulemaking. As explained in reply to question 1 above, many of the FRA's rules apply to standard gage track operations and should be considered as inapplicable to VHO's modern magnetic levitation fixed guideway system. Potentially, a new regulatory approach for hyperloop transportation could involve some use of guidance and, while including some rules, need not include as many rules as those in place today for standard gage track operations. Were USDOT to take the view that developing a safe system for hyperloop cannot proceed unless all aspects are governed in detail by rules, that would be burdensome. We consider that guidance and agency orders could to some extent limit, but not eliminate the need for new rules while reducing regulatory burdens compared to what is in place now.

In addition, there can be new issues to address that should be handled in a way that limits regulatory burden. For example, VHO's fixed guideway is enclosed and at low air pressure to reduce drag and facilitate high speed transportation. The aviation industry has experience designing equipment for low air pressure use and FAA rules include material of interest to VHO in this regard.

We certainly do not consider the hyperloop to be an airplane, but we have considered aspects of FAA's rules in designing the pod as well as various industry practices and other sources. It is not clear that pod design must be addressed by rule. USDOT could determine through guidance or orders that the pod's design is more than sufficient based on review of industry standards or portions of FAA rules that VHO chose to bring to bear in designing the pod for use in surface transportation.

To the extent that an FRA rule is not limited to standard gage operations, and potentially applicable to hyperloop transportation, rulemaking may well be a factor. In using the word “rulemaking” here, we are mindful that waivers and rules of particular applicability (RPAs) go through the notice and comment process and, in that sense, are in the nature of rulemaking actions. To the extent FRA rules are not limited to standard gage and VHO would like relief from them, there are two approaches. We could ask to make a specific rule more flexible by allowing a waiver or rule of particular applicability to make it performance-based. Or, VHO could seek waivers or an RPA so that it would no longer be applicable.

An example of the latter would be any rule to the extent it imposes a requirement with respect to at grade crossings. As there are no such crossings on the VHO Hyperloop System, we likely would seek relief, such as from a waiver or RPA, to exclude applicability to the VHO hyperloop system, of any such requirements. We are continuing to review FRA rules to this end.

As to safety, we emphasize that hyperloops will be constructed as a physically separate standalone system with new technology for the vehicles and operating systems. There are no at grade crossings or shared track. These are all safety enhancing features, facilitating adoption of a performance-based approach. We expect improved safety from hyperloops compared to current technology and we consider flexible, performance-based regulation as enhancing safety, focusing on performance rather than on details of equipment or processes.

In particular, the flexibility of a performance-based approach to allow a modification to equipment or a process, within the parameters of the rule, allows rapid implementation of better technology and improved safety. When rules impose rigid design or process requirements, improvements cannot be effectuated without first achieving a change to the rule. That slows down safety improvement.

4. If you identified a barrier to innovation in response to Question 1 or 2, above, is legislation necessary to remove or mitigate that innovation barrier? Please identify the barrier with specificity, explain why it is a barrier, and identify the specific law that you believe should be changed. Please describe how it should be changed and why there will be no adverse impact to safety.

Reply: We have explained above (see reply to question 1) that it appears that USDOT can construe many of the FRA’s rules as inapplicable to hyperloop because the rules are drafted as applying to standard gage track operations. We have also explained that, for FRA rules not limited to standard gage, USDOT could develop waivers from rules or rules of particular applicability or a combination thereof so that hyperloop transportation could be governed by a suitably modern and flexible framework, rather than a traditional detailed equipment or process rule. So, as noted earlier, we consider that USDOT has the authority to regulate hyperloop transportation in a safe and modern way.

However, should USDOT not make effective use of that authority, or if an opportunity for legislation should arise, it could become appropriate to give increased consideration to pursuing legislation in order to ensure that rules drafted for traditional rail operations are not applied to hyperloop technology.

However, we are hopeful that USDOT will see the merit of rapidly making regulatory decisions that result in a new, modern regulatory approach for hyperloops, not a dated, burdensome one drafted for traditional rail operations. Further, we see safety improvement, not safety risk from the deployment of hyperloop transportation, in part due to world class technology and in part due to the absence of at grade crossings and shared track environments. We hope those factors further encourage USDOT to make regulatory decisions that result in a new, modern regulatory approach for hyperloops.

5. Do you believe that there are international bodies or organizations (at any level) that the Department should be working with to develop standards or best practices for potential application to non-traditional and emerging transportation technologies in the United States?

Reply: Interest in the development and deployment of hyperloop service is not limited to the United States, to U.S. companies, or to U.S. governments. In Europe, the Directorate-General for Mobility and Transport (DG MOVE), in conjunction with the Shift2Rail Joint Undertaking, is currently exploring hyperloop standards and safety cases with European Union member states, European standards and regulatory experts, and hyperloop technology developers. This has included establishing a dedicated working group with all applicable parties to focus on advancing the process of hyperloop development across the European Union. In Canada, Transport Canada has undertaken a study to evaluate different hyperloop technologies to understand how it can best advance the industry. In India, the Principal Scientific Advisor (PSA) under the office of the Prime Minister has established the Consultative Group on Future Transportation (CGFT). This group is currently carrying out research, development and building the regulatory framework. The former Government of Maharashtra also undertook the steps to declare hyperloop an official public infrastructure project between the cities of Mumbai and Pune with VHO being designated as the Original Project Proponent (OPP). Work is also underway in geographies such as the Middle East towards the development of a regime that would make clear what safety requirements a hyperloop must meet to be allowed to operate in those places.

VHO respectfully suggests that the USDOT's interest in world leadership in transportation, transportation safety and innovation may warrant an effort by USDOT to be prompt in developing a regulatory regime allowing commercial operation of hyperloops within the U.S. Further, the opportunities for deployment of commercial hyperloop service in other countries may require a U.S.-based hyperloop company to comply with non-U.S. rules. Accordingly, it would be problematic if a hyperloop company were to have to comply with rules from different countries or organizations that were not compatible with U.S. rules. Implications for manufacturing and equipment that conform to U.S. and international rules and development of projects could be burdensome and more costly.

We do support efforts by U.S. authorities to communicate with bodies from other countries but wish to emphasize that U.S. leadership in developing a safety regulatory regime for hyperloop transportation is important and that the U.S. should not be passive and wait for other nations or multi-nation bodies to act.

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6. Does the current landscape of State/local/Tribal regulation for non-traditional and emerging transportation technologies hinder or support innovation?
- What laws or regulations do State, local, or Tribal governments rely upon, other than Federal transportation laws and regulations, to regulate the safe design, construction, and operational safety of non-traditional or emerging transportation technologies (e.g., hyperloop and non-traditional tunneling)? In what ways do these laws or regulations hinder or support innovation? (Please be specific in your response.)
 - Are there State/local/Tribal occupational license regimes that govern the safe conduct of operators of non-traditional or emerging transportation technologies? Do they hinder or support innovation?
 - Are there State/local/Tribal laws that assist innovators in developing safe prototypes, road testing, deploying, or commercializing new transportation technologies? (Comments on regulatory gaps or feasibility studies and analyses are encouraged.)

Reply: VHO has found growing enthusiasm for hyperloop transportation in the U.S. and abroad. Should this continue, we are hopeful that state/local/tribal law and regulation will not prove to be an obstacle to hyperloop transportation. We are hopeful that the industry, USDOT, and state, local and tribal authorities will work cooperatively together and expeditiously to deliver hyperloop service to the public.

7. Would intermodal or cross-sector regulations support or inhibit innovation and ensure safety of transportation infrastructure, as well as the safe movement of goods, services, capital and the traveling public? Please explain why or why not. Include specific examples, studies, or other data if available.

Reply: Hyperloop transportation is new and transformative technology. We have recommended that it be regulated with a performance-based approach. Constructing regulations applicable to multiple modes, such as hyperloops, trucks, airplanes and pipelines, may inhibit innovation, as one mode could be held back as a rule is recrafted to make it “work” for all the modes that the rule is supposed to address.

8. Would cross-sector or cross-modal transportation safety regulations support or inhibit investments in non-traditional and emerging transportation technologies? Please explain why or why not. Include specific examples, studies, or other data if available.

Reply: We see differences in the safety issues facing the different modes. Investors tend to focus on particular investments (single company or, perhaps, mode). So, it is not clear that a multimodal safety effort would unlock investment. To the extent that developing a rule to fit many modes would increase costs for a mode, compared to a mode-focused approach, it certainly would not encourage investment.

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9. How can Federal policies, regulations, or legislation be used to foster mobility service providers, remove barriers to new non-traditional and emerging transport operations, or promote safe, efficient, environmentally sound and user-friendly mobility systems? Please explain, using specific examples where feasible.

Reply: As noted, key steps needed to advance hyperloop transportation include:

- USDOT must provide clarity as to how hyperloop will be regulated (we suggest in a modern way within the framework of the rail safety statutes and, for certain short routes, as transit).
- The decision should be made promptly.
- The regulatory approach should be performance-based and not prescriptive.
- Hyperloop projects should be eligible for federal transportation, new technology and other funds, apportioned or discretionary, to the same extent as rail, maglev, or rail transit.

These steps are particularly appropriate because hyperloops are safe by design, with no at grade crossings or shared track with others, and with operations in a controlled environment (tube) that prevents departures from the fixed guideway. If action is taken promptly on the regulatory approach, these safety benefits will be realized sooner. In addition, hyperloop has no direct emissions and uses less right of way than other transportation options. If action is taken swiftly on the regulatory approach, these environmental benefits will be realized sooner.

10. Technology Companies/Innovators: What standards or code of conduct are relevant to ensuring a balance between supporting innovation and ensuring the safety of transportation infrastructure and the traveling public?

Reply: VHO is strongly committed to safety and plans to meet requirements as developed by USDOT. We see this as a case by case effort. Overlaying any additional “code of conduct” over rules could well be confusing and create a burden in addition to the applicable rules. As part of its thorough effort to advance hyperloop technology and deployment, VHO has reviewed many industry standards and documents for potential use. Below in Table 1 is an extract of helpful information we have found. This highlights the importance of standards and codes of practice in supporting the development of hyperloop technology, in furthering innovation and furthering public safety. The referenced materials are existing standards or plans in four important areas: infrastructure; product engineering; safety and operations; and quality assurance.

Table 1. Examples of Existing Standards, Applicability and Types

| | | Applicability | Standard Type |
|---|---|-----------------------|-------------------------|
| Infrastructure Standards | | | |
| APTA-PR-CS-RP-001-98 – 034-99 | APTA Passenger Rail Equipment Safety Standards (PRESS) (construction and structural) | Hyperstructures | Application |
| AS 5100.5 | Concrete Design Principles | Hyperstructures | Application |
| NASA-HDBK-5005D | Standard for The Design and Fabrication of Ground Support Equipment | Hyperstructures | Application |
| NFPA 101 | Life Safety Code | Hyperstructures | Application |
| NFPA 5000 | Building Construction and Safety Code | Hyperstructures | Application |
| Product Engineering Standards | | | |
| NASA-HDBK-7004C | Force Limited Vibration Testing | Pod | Product |
| ASHRAE 62.1 | Ventilation for Acceptable Indoor Air Quality | Pod | Product |
| NFPA 130 | Standard for Fixed Guideway Transit and Passenger Rail Systems | Pod | Product |
| APTA PR-CS-S-034-99, Rev.2 | Standard for the Design and Construction of Passenger Railroad Rolling Stock | Pod | Product |
| APTA-PR-E-S-013-99 Re v 1 | Standard for Emergency Lighting System Design for Passenger Cars | Pod | Product |
| DOT-VNTSC-FAA-05-01 | Operational Guidelines for Spaceflight Pressure Vessels | Pod | Product |
| ISO 2631-1 | Mechanical vibration and shock - Evaluation of human exposure to whole-body vibration - Part 1: General requirements | Pod | Product |
| IEC 61140 | Protection against electric shock – Common aspects for installation and Equipment | Pod | Product |
| IEC 60068 | Environmental Testing (hardware qualification of electronic equipment, components and electromagnetic products) | Pod | Product |
| Safety, Security and Operational Standards | | | |
| ANSI/STD B11.19 | Performance Criteria for Safeguarding | Safety/ Operations | Generic |
| APTA-PR-IM-S-001-98 – 017-02 | APTA Rail System Standards (Vehicle Inspection and Maintenance) | Safety/ Operations | Generic |
| IEC 62278 | Railway applications - Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) | Safety/ Operations | Generic |
| IEC 62279 | Railway applications - Communication, signalling and processing systems - Software for railway control and protection systems | Quality Assurance | Product/ Application |
| FTA | National public transportation safety plan - 2017 | Safety/ Operations | Generic |
| MIL-STD-882E | Standard Practice System Safety | Safety/ Operations | Generic |
| ISO/IEC 27001 | Information technology - Security techniques - Information security management systems - Requirements | Security | Generic |
| ISO/IEC 27002 | Information technology - Security techniques - Code of practice for information security controls | Security | Generic |
| ISO/IEC 31010 | Risk management - Risk assessment techniques | Safety/ Operations | Generic |
| Quality Assurance Standards | | | |
| ISO 9001 | Quality management systems — Requirements | Quality Assurance | Generic |
| ISO/IEC TR 90005 | Systems engineering — Guidelines for the application of ISO 9001 to system life cycle processes | Quality Assurance | Generic |
| ISO/IEC/IEEE 90003 | Software engineering - Guidelines for the application of ISO 9001:2008 to computer software | Quality Assurance | Generic |

11. Technology Companies/Innovators: What actions can the NETT Council take to support your work, while maintaining its safety focus?

Reply: As noted, key steps needed to advance hyperloop transportation include:

- USDOT must provide clarity as to how hyperloop will be regulated (we suggest in a modern way within the framework of the rail safety statutes and, for certain short routes, as transit).
- The decision should be made promptly.
- The regulatory approach should be performance-based and not prescriptive.
- Hyperloop projects should be eligible for federal transportation, new technology and other funds, apportioned or discretionary, to the same extent as rail, maglev, or rail transit.

These steps are particularly appropriate because hyperloops are safe by design, with no at grade crossings or shared track with others, and with operations in a controlled environment (tube) that prevents departures from the fixed guideway. If action is taken promptly on the regulatory approach, these safety benefits will be realized sooner. In addition, hyperloop has no direct emissions and uses less right of way than other transportation options. If action is taken swiftly on the regulatory approach, these environmental benefits will be realized sooner.

a. At what point in the development of the technology or operation would it be ideal to interface with the NETT Council?

Reply: Early interaction is important, so that a regulated entity would better understand government concerns. Early interaction also would help avoid misdirected effort and resources. Prompt action by USDOT, such as through the NETT Council, in outlining the safety regulatory path forward for hyperloop transportation, is also very important.

b. Considering the resource constraints and the potential cross-modal nature of non-traditional and emerging transportation technologies, would an on-going relationship with the NETT Council during the development and construction of your project be helpful to assess potential safety risks and unintended consequences be helpful? If so, how often should engagements occur?

Reply: Yes, ongoing meetings are valuable to get and stay on course and to ensure good communication. When a transportation system or type of vehicle is being designed, built, or undergoing early operational testing, it is most important for the regulator and the regulated to have frequent dialogue, setting the stage for smooth communication and success in the final stages of development.

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12. Local, State, Tribal, and Other Public Entities: What support should the NETT Council consider providing when non-traditional/emerging transportation technology companies propose a non-traditional or emerging transportation technology or system in your jurisdiction?
- In what way could Federal action help maintain the overall safety of the design, construction, and operation system? What aspects do you believe are best addressed by State, local, and Tribal entities? Please provide specific examples to support your comment.
 - In what way could Federal actions assist you in overseeing any risks (safety or other) and unintended consequences that are local in nature? In what way could they interfere with your oversight and enforcement authorities? Please provide specific examples to support your comment.
 - In what way could Federal actions improve or clarify oversight roles? Please provide specific examples to support your comment.

Reply: While not a state, local or tribal government, VHO suggests that it would be constructive for the NETT Council to advise non-federal government entities that the federal government has important safety regulatory authority. This may better enable an applicable non-federal government to focus on tasks that would not overlap with the work being undertaken by USDOT. The NETT Council also may wish to advise the state, local and tribal entities, as applicable, of opportunities to apply for federal funds.

13. Local, State, Tribal, and Other Public Entities: Has a company approached you about a non-traditional or emerging transportation technology? If so, are there any best practices you can share from working with companies that could shape how the NETT Council approaches non-traditional or emerging transportation proposals?

No reply.

Conclusion

Virgin Hyperloop One thanks USDOT for its strong interest in hyperloop transportation opportunities and issues, as evidenced by the work that went into the development of this docket. But, much more remains to be done.

As noted at the outset, interest in hyperloop service is strong and growing in the U.S. and around the world. It is timely for USDOT to work promptly to determine and inform VHO, other stakeholders and the public of the safety regulatory path or paths forward for hyperloop transportation. That action would greatly facilitate development, testing and deployment of hyperloops and the many public benefits that would follow – including the creation of jobs, economic efficiency, and faster transportation service.

We have also outlined the merits of a performance-based approach to safety regulation of hyperloop transportation and important points regarding eligibility for funding and the ability to make skillful use of third-party validators and verifiers as part of a regulatory approach.

We see significant social and economic benefits from developing hyperloop service and a hyperloop industry. We also see transportation, safety, and environmental benefits. As hyperloop transportation will provide public benefits, we have also recommended making clear that hyperloop projects are eligible for federal transportation, new technology and other funds, apportioned or discretionary, to the same extent as rail, maglev, or rail transit.

The United States has the opportunity to take the lead and achieve consequential and long-lasting benefits from hyperloop deployment, but other nations are also demonstrating significant interest in hyperloop transportation, with implications for transportation leadership and the economy.

Accordingly, Virgin Hyperloop One recommends that further action by USDOT on hyperloop transportation be in accord with these comments and that such action be taken expeditiously. VHO is eager to cooperate with USDOT so that safe deployment of hyperloop transportation can occur as promptly as possible.

We thank USDOT for its consideration.