

# Why Airworthiness Certification is Necessary for Commercial Human Spaceflight

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America's national spacefaring enterprise is changing at a pace that has not been seen since the 1960s when space was first accessed on a routine basis. President Trump's plans for a US Space Force, others calling for a US Space Guard, a renewed focus on reusability in space launch and on American human space exploration and commercial human spaceflight, and Congressional interest in space-based ballistic missile and satellite defense, are all putting America's spacefaring future in the public spotlight.

America will not effectively become a true human spacefaring nation without the ability to achieve "aircraft-like access to space." In this article, I focus on what "aircraft-like access to space" means and why achieving airworthiness certification for commercial passenger spaceflight is necessary to enable aircraft-like access to space to be safely and ethically achieved. (A US Space Force and a US Space Guard will need a comparable capability for any crewed operations they might conduct in space.)

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## Understanding what "aircraft-like access to space" means

As you read this on a typical morning or afternoon, thousands of commercial airliners, carrying around a half-million people, cruise America's skies in comfort and safety, as illustrated above. Air travel's convenience makes it the preferred means for most business and leisure travel. This past July 4th holiday, more than three million Americans traveled by air. We are now 60 years into the jet age of commercial air travel and this industry's safety and convenience define what "aircraft-like" means to the public.



Illustration of the Orion III passenger shuttle from the movie "2001: A Space Odyssey". The Orion III shuttle was the second stage of a two-stage-to-orbit system. (Model credit: B.J. West. Illustration credit: Mike Snead)

In the mid-1960s, during the first decade of the human space age, director Stanley Kubrick set out to forecast what our spacefaring civilization would be doing 30 years in the future, in 2001. America's human spaceflight program was then just beginning two-person missions with the Gemini program. Author Adam K. Johnson superbly records, in *2001: The Lost Science*, the technical and industrial expertise Kubrick harnessed in preparing the movie. Kubrick's depiction of the two-stage-to-orbit Orion III passenger shuttle established our expectations of what "aircraft-like access to space" should be like. While some see the traditional aircraft-like appearance of the Orion III to be what "aircraft-like access to space" means, aerospace engineers understand that the key attribute—as depicted by Dr. Heywood Floyd sleeping in the passenger compartment of the Orion shuttle—was flight safety or airworthiness.

For leisure air travel, Americans routinely take their children while older children often travel by air unaccompanied. Especially with the safety of our children being paramount, the public has high expectations for the safety of air travel. If we are to normalize human space travel, then it must also be made acceptably safe so that working adults—many who have families—will be able to travel to, from, and within space with safety comparable to air travel.

For aircraft, acceptable safety is achieved through airworthiness certification. Comparable airworthiness certification will be needed for human spaceflight systems to achieve “aircraft-like access to space.” Whether the actual space flight system has wings, takes off from a runway, or launches vertically from a pad is not relevant to achieving “aircraft-like” access to space. How it is accomplished is up to the engineers, provided acceptable safety can be adequately demonstrated to an independent federal agency legally charged with protecting the safety of the involved and non-involved public.

### **Why airworthiness is a legal and ethical necessity**

To understand the legal need for airworthiness, we need to start with the roots of how a legal obligation for commercial safety came about. The legal obligation for business owners and operators to be responsible for the safety of their customers arose, per my understanding, nearly 4,000 years ago in the ancient [Code of Hammurabi](#).

If a builder build a house for someone, and does not construct it properly, and the house which he built fall in and kill its owner, then that builder shall be put to death.

This criminal legal code—essentially an “eye for an eye” act of vengeance for a harm having been caused—was the basis of Western civilization’s law for several millennia. Two thousand years later, in ancient Rome, accountability expanded to hold a business owner at fault even if the act causing harm was done by an employee or slave. Roman law held that the shipowner and innkeeper “was to a certain degree guilty of negligence in having employed the services of bad men.” The owner incurred guilt even though someone else may have been directly to blame.

This Roman law obligation continued until the emergence of British common law in the 1400s. Not being a lawyer, my understanding is that British common law is based on the concept of legal precedence where court decisions (and British customs) establish the law going forward.

In the late 1500s and early 1600s, British common law established that those engaged in business with the public carried a legal obligation “to exercise his art rightly and truly as he ought.” Over time, this obligation became known as a “duty to care”. Those engaged in the transportation of people—legally referred to as passengers—clearly carried this obligation as it was not realistic that a passenger could know if a vehicle was roadworthy or a ship was seaworthy and adequately provisioned for the voyage. (It is my understanding that the commercial use of the term “passenger” implies acknowledgement of the “duty to care” obligation. Some companies now talk about taking fare-paying individuals to space rather than using the term “passenger.” This comes across to me as an intentional avoidance of acknowledging a duty-to-care obligation. Also, I believe some writers incorrectly use the term

“passenger” when discussing what federal law now refers to as “spaceflight participants”. Such likely incorrect use only confuses the public.)

In the United States, each individual state defines the law governing the duty-to-care obligation for commerce within the state. However, for interstate commerce, the federal government regulates the duty to care obligation through its constitutional power “to regulate Commerce with foreign Nations, and among the several States, and with Indian Tribes.”

In the 1800s, as industrialization took hold, technology advanced rapidly. Construction with metals replaced stone and timber. Steam engines powered land and water transportation. Electricity was commercialized. By the late 1800s, injuries due to faulty construction and equipment failure increased significantly. Improperly prepared foods and drugs caused illness and death. Congress took steps to impose safety regulations to protect the public and workers from harm and to alleviate some lawsuits by having the federal government assume some responsibility for assuring safety. This was achieved by imposing design and operating requirements and undertaking independent safety inspections. Railroads were addressed first followed by food and drug regulation.

### **The emergence of the profession of engineering**

The world’s transition to industrialization in the 1800s was enabled by the steam engine; the genius invention of Thomas Newcomen in 1712 which enabled a simple fire to produce useful mechanical power. Industrialization requires the ability to use metals in safety-critical applications—such as steam boilers—where failure can lead to injury and death. In addition to civil engineering—focused on roads, bridges, canals, and ports—mechanical engineering emerged to handle industrialization.

As the United States saw the need to regulate industrialization to achieve acceptable safety, the professional role of engineering changed accordingly. Engineers increasingly relied less on “rules of thumb” and more on scientifically-established principles and practices to design safety-critical machines and installations. Notable failures of boilers, bridges, and

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dams, as examples, hastened the awareness of the need for these changes. In 1907, Wyoming began the examination and registration of anyone engaged in engineering to clarify that a duty-to-care obligation existed for engineering works that impacted public safety and that only registered professional engineers could legally carry out such work. (A similar process now exists in many fields, such as architecture and medicine.) From this start arose the engineering ethical obligation, adopted by professional engineering societies, to protect the public from avoidable harm by using the best available principles and practices.

## **The emergence of airworthiness**

In the 1920s, Congress passed laws creating the need for the emerging airline and aircraft manufacturing industry to achieve federal airworthiness certification. The fledgling airlines were suffering an unacceptable number of accidents. With airlines clearly interstate commerce, and with Congress taking steps and investing federal funds to promote air travel, the imposition of airworthiness certification to boost the public's confidence in the fledgling industry's safety was a logical step. The positive results speak for themselves. Air safety improved, making air travel increasingly common. Part of this process was the adoption of specifications and standards for the manufacture of materials and some parts used to build aircraft (e.g., fasteners), and for the methods used to design, build, test, and inspect aircraft. Many of these specifications and standards became military procurement specs and standards during World War II and the ensuing Cold War.

In the United States, airworthiness certification negates the need for engineers engaged in the human flight industry to be registered professional engineers (PE) or work for a PE. In other commercial engineering disciplines, the PE's act of signing or stamping an engineering document or drawing acknowledges the PE's legal responsibility for the work. (In a field where such a requirement exists, only a PE is properly referred to as an engineer.) If something goes wrong through error, the PE is held responsible. While there may still be independent inspections, such as building inspections, the PE remains legally responsible.

The federal civil, commercial, and military airworthiness certification processes essentially remove the requirement that a PE oversee and be responsible for the work. (However, within the aerospace industry, many engineers are PEs—doing this, often, to show personal adherence to professional ethical obligations.) The primary reason for this difference is that the airworthiness certification process includes substantial ground and flight testing, often including the ground testing of articles to failure to verify the conservatism of the predicted performance. Such destructive testing cannot be replicated for typical terrestrial constructions such as bridges, buildings, and dams. Government engineers and pilots, especially for military systems, have access to and often directly observe the airworthiness testing and undertake government flight testing.

In having the final say about the aircraft's airworthiness, the federal government assumes the duty-to-care responsibility when it issues an airworthiness certificate. For civil and commercial aircraft, the Federal Aviation Administration (FAA) directs the procedures and processes to be followed to achieve and maintain airworthiness and correct deficiencies that are later identified. The military has comparable airworthiness procedures and processes but extends its oversight role to include performance and mission capability.

## Benefits of government safety certification

Today, most businesses operate quite successfully within a framework of government safety oversight that limits the public or employee's possible harm when they engage in commerce. Per my understanding, with the government inspectors' independent approval, the business operator's duty-to-care obligation is met. This shields the business operator from legal claims of harm except where negligence can be proven. Also, when an approved product or operation is used, no informed consent is required, absent some further consideration due to age or health. Obviously, this legal protection benefits commerce significantly. Of course, mistakes can happen and unexpected failures can occur that cause harm. When this happens, safety criteria and requirements are modified to try to prevent a reoccurrence. Impacted systems are withdrawn from service until appropriate inspections and changes are made and recertification is achieved. (The FAA issues Airworthiness Directives to mandate needed changes.) The intent of government safety oversight is not to prevent all harm, but to keep the occurrence at an acceptable very low rate such that normal commerce can proceed without undo concern or serious disruptions should failures occur.

An often-overlooked aspect of this safety regime is that it also helps to shield professionals working in private industry from legal risk. The business owners and operators understand that the safety of their product or service will be thoroughly reviewed by independent experts before commercial use can begin to verify that approved safety protocols have been implemented. Identified deficiencies will be corrected, often at a substantial additional expense. Intentional acts resulting in unsafe products or services may have both civil and criminal consequences. Practicing professionals benefit because independent safety certification helps to prevent unsafe products and services from entering commercial use and causing harm.

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## Airworthiness does not preclude technology advancement

As everyone is aware, there is a surge in interest and private investment in electric-powered, VTOL air taxis that will carry fare-paying passengers. Rather than trying to avoid airworthiness certification—perhaps by claiming that mandating airworthiness precludes rapid technology advancement—electric VTOL air taxi developers are working closely with the FAA to make sure that airworthiness is achieved.

[One such prototype two-person air taxi](#) has received an experimental airworthiness certificate permitting test flights with two people on board to simulate passengers being transported by the taxi. The pilot would remain on the ground as the vehicle only carries two people. The test

participants cannot be fare-paying passengers. With final airworthiness certification, the air taxi would operate carrying fare-paying passengers even if this was just for a local “joyride” to see the sights from the air. There is no reason why this model of handling technology advancement should not be applied to commercial human spaceflight.

### **Informed consent use in commerce**

Going back to the 1500s, common law established a duty-to-care obligation by those engaged in commerce to protect the public. Under some circumstances, such as war or piracy, this obligation is waived. In modern times, it has also been waived in some areas of intrastate commerce.

Informed consent in voluntary commerce—as opposed to medical treatment—ethically requires that a reasonable person understands the risks. One common example where state laws permit the use of informed consent is river rafting. While rafting is a form of transportation, whitewater river rafting is deemed to be entertainment and not subject to the duty-to-care obligation required for fare-paying passenger transport. The distinction appears to be that such rafting does not exist to transport a person to a destination.

Not being a lawyer, it is my understanding that the legal presumption is that the simplicity of rafting enables responsible adults to make an informed decision regarding the inherent risks of injury or drowning. Does the raft appear sound? Is the guide competent and not intoxicated? Are the water conditions abnormally dangerous, such as following heavy rains? Is the safety equipment, such as helmets and life jackets, in good condition? If customers conclude that they should be safe, they sign an informed consent waiver absolving the rafting company of liability in most circumstances. The state may impose some basic regulations, such as wearing life vests and helmets, setting a minimum age or physical condition, or not being intoxicated, but the rest is left up to the adult or, in the case of older children, the parent or guardian to decide. Hence, rafting, mountain climbing, and similar commercial activities are permitted because it is presumed that an informed decision regarding one’s safety can be made. Further, the adult can physically inspect the equipment and question the operators to enhance their understanding and evaluation of the risk.

State court decisions determine any exceptions to the use of informed consent. When harm occurred on one rafting trip, an attempt to sue under the duty to care obligation was turned back by the court because, per my understanding, an informed consent waiver had been signed and this was deemed adequate for this form of entertainment commerce. However, in another case, when harm occurred on a theme park ride, the state court decided that the duty to care obligation held, overturning the expectation that purchasing a ticket to the theme park constituted giving informed consent.

Imagine trying to apply an informed consent approach to the electric VTOL air taxis if used for pure sightseeing—a form of entertainment travel comparable to river rafting. Would a simple visual inspection of the aircraft provide sufficient information for a typical adult to ascertain its airworthiness? With no pilot, who would be asked pertinent questions? If being used as a taxi to a destination, would it be ethical for a company to demand its employees, as a condition of employment or advancement, use such an aircraft that lacked airworthiness certification, requiring instead that an informed consent be signed absolving the employer and the operator of legal liability?

### **Informed consent and commercial human spaceflight**

No company, to the best of my knowledge, is currently seeking airworthiness certification of a commercial human spaceflight system. Thus, an informed consent approach appears to be the way commercial human spaceflight is now being pursued. The inherent presumption appears to be that a typical adult can, of their own accord, determine whether the risk is acceptable such as is now done for entertainment rafting. Obviously, human spaceflight systems will be far more complex than river rafts, theme park rides, or even, the new air taxis.

At what level of complexity does it become unreasonable to expect that a typical adult can, of their own accord, make a determination whether the risk is acceptable? Is it not the case that the inherent complexity of commercial human flight was why airworthiness certification was implemented: to take slick marketing and profit-seeking out of the safety decision process so that the air travel industry could mature and prosper? Imagine a commercial human spaceflight operator offering fare-paying service to transport people to Earth orbit. For commerce to develop in space, companies will require employees to travel to space. If it would not be ethical for the company to demand that employees consent to using air taxis that are not airworthiness certified, why would it be ethical to demand that they consent to travel to and from space on flight systems that are not airworthiness certified?

**The emerging electric VTOL air taxi industry is leading the way by embracing airworthiness as the means to provide a proper safety foundation for their industry. The federal government is working closely to make this a success. In sharp contrast, the US private commercial human spaceflight industry is on a road to oblivion.**

### **Today's road to oblivion**

With recognition that reliance on an informed consent approach to commercial human spaceflight is ethically wrong and, as courts may determine, contrary to the long-held common law duty-to-care obligation, it is clear that America's human spacefaring enterprise is still dead in the water. Despite the billions being spent, America is not yet developing a true commercial passenger spaceflight industry.



As I have pointed out elsewhere, shortly after SpaceShipOne won the Ansari X PRIZE for private, suborbital human spaceflight, it was loudly touted that commercial human suborbital spaceflight was just a couple years away. Congress was told to stand aside and just let private industry takeover. More time has since elapsed without such a commercial capability coming into operation than it took this nation to land humans on the Moon after President Kennedy's 1961 speech. Further, the operators of the suborbital systems now being developed appear to plan to rely upon the informed consent approach to safety. What is being developed is fancy river rafting trips for the wealthy. While some people champion this as progress, clearly it is not.

The emerging electric VTOL air taxi industry is leading the way by embracing airworthiness as the means to provide a proper safety foundation for their industry. The federal government is working closely to make this a success. In sharp contrast, the US private commercial human spaceflight industry is on a road to oblivion. Strong federal government leadership is now required to correct this situation by focusing on airworthiness-certified "aircraft-like access to space" system development that will foster the creation of a commercial passenger spaceflight industry.

A US Space Force may require a military human presence in space to achieve the dominance that President Trump desires. For this reason, it is time for the military to lead in advancing America's human spaceflight industrial mastery. As was done with the new US Air Force's leadership in advancing jet aviation after World War II, such federal government leadership will enable military and commercial airworthiness-certified aircraft-like access to space to become as safe and routine as air travel is today.

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