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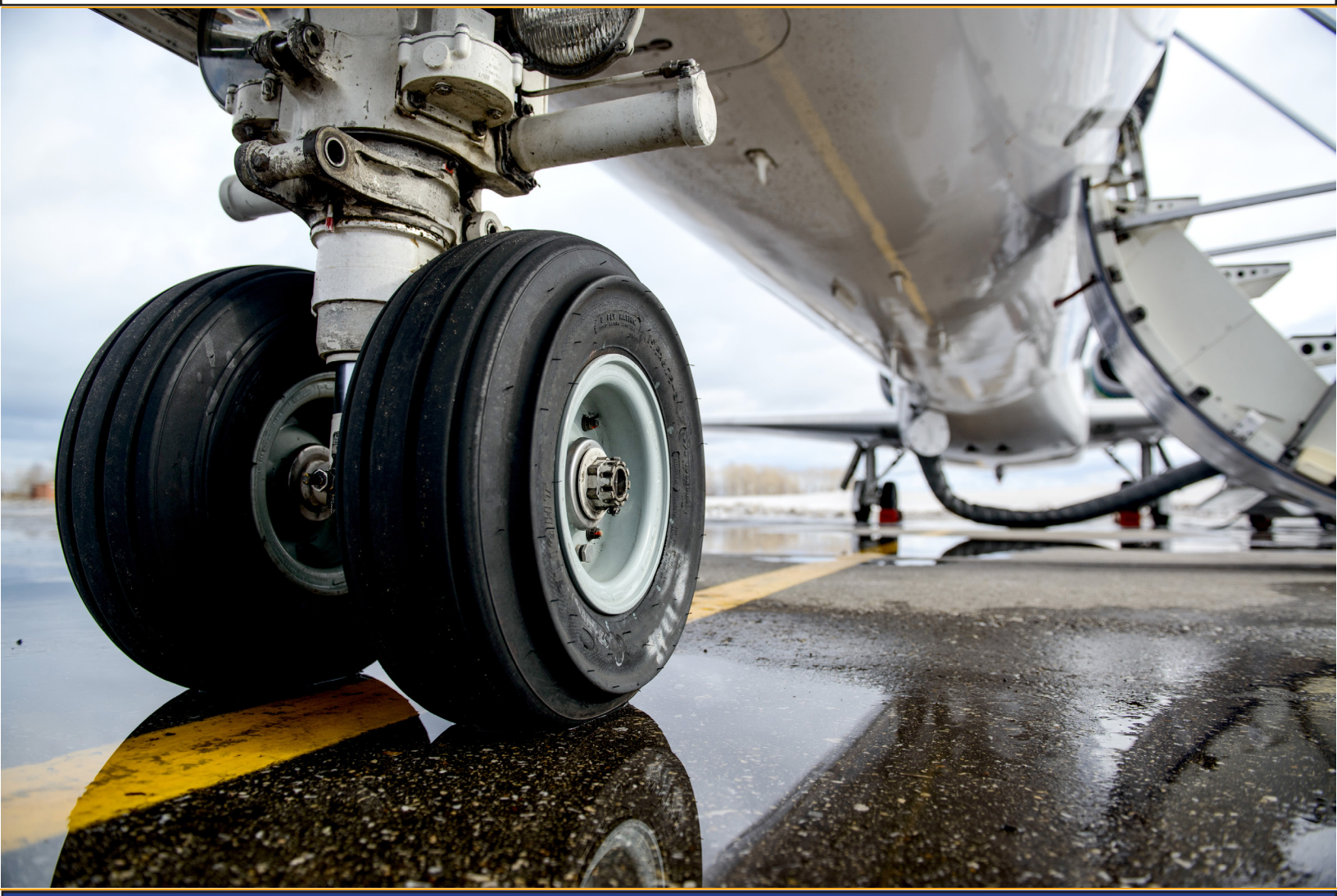

Safer, Faster, Cheaper:

Aviation Certification for the 21st Century

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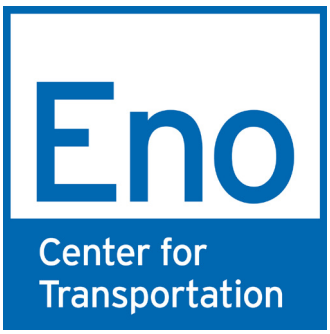

Authors

Robert Puentes, President and CEO
Rui Neiva, Policy Analyst

Special thanks to the Aviation Working Group

About Eno and the Aviation Working Group

The Eno Center for Transportation is an independent, nonpartisan think tank that promotes policy innovation and leads professional development in the transportation industry. As part of its mission, Eno seeks continuous improvement in transportation and its public and private leadership in order to improve the system's mobility, safety, and sustainability.

The Aviation Working Group is an advisory group on all matters related to aviation policy and practice. The group is made up of diverse experts and stakeholders. It provides Eno with insights, knowledge, feedback, and guidance on how to continue to lead the world in aviation safety, modernization, and innovation. The group is co-chaired by former Secretary of Transportation Jim Burnley and former Senator Byron Dorgan.

CONTACT: Ann Henebery, Communications Manager, Eno Center for Transportation
EMAIL: ahenebery@enotrans.org
www.enotrans.org | 202-879-4700

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List of Abbreviations

ACE – Aviation Certification Exchange
AEC – Atomic Energy Commission
AFS – Flight Standards Service
AIR – Aircraft Certification Service
ARC – Aviation Rulemaking Committee
ATC – Air Traffic Control
CAST – Commercial Aviation Safety Team
CFR – Code of Federal Regulations
DOA – Design Organisation Approval (EASA)
EASA – European Aviation Safety Agency
FAA – Federal Aviation Administration
FDA – Food and Drug Administration
FMVSS – Federal Motor Vehicle Safety Standards
FRA – Federal Railroad Administration
GAO – U.S. Government Accountability Office
ICAO – International Civil Aviation Organization
NASA – National Aeronautics and Space Administration
NextGen – Next Generation Air Transportation System
NHTSA – National Highway Traffic Safety Administration
NRC – National Research Council
NTSB – National Transportation Safety Board
ODA – Organization Designation Authorization (FAA)
OIG – U.S. DOT's Office of the Inspector General
PDUFA – Prescription Drug User Fee Act
PRA – Probabilistic Risk Assessment
PTC – Positive Train Control
SMS – Safety Management System
U.S. DOT – U.S. Department of Transportation

Executive Summary

Establishing, implementing, and overseeing the standards for design, production, operation, and maintenance activities is the Federal Aviation Administration's (FAA) most important mission. The critical role of implementation—known as certification—ensures public confidence in the safety of the system for business and leisure travel. The high level of aviation safety in the United States is the result of continuous improvement of these elements by industry and government over many decades.

Strict adherence to these standards helps maintain the strong demand for U.S. aviation products worldwide. This is true not only for aircraft design and production, but also in operations, maintenance, and air traffic control modernization. Due in part to these high standards, aviation is a strong contributor to the U.S. economy and is responsible for 5.4 percent of the country's gross domestic product. The aerospace industry's trade surplus of $82.5 billion is the largest within the U.S. economy.

Despite continuous work on improving the certification system, industry stakeholders and experts have raised concerns about the efficiency and functionality of FAA's certification and approval processes for products, operations, maintenance, and other areas. Without a strong and agile agency that can both maintain and improve safety, the continuity of the American aviation industry as a global leader is at risk.

The Eno Center for Transportation Aviation Working Group brought together key stakeholders to study this issue and propose pragmatic, innovative, policy solutions to improve the FAA's certification processes while maintaining aviation's impeccable safety record. This report is the product of that effort and focuses on three areas of certification:

1. *Aviation products and their components;*
2. *Air traffic control and air traffic controllers;*
3. *Repair stations.*

The report includes an overview of these areas and a historical analysis that examines over 35 years of FAA certification processes. By working closely with the industry, FAA has achieved high safety levels, and the focus has shifted to the certification procedures themselves, their efficiency and effectiveness.

Reform is needed because the aviation industry is rapidly changing and growing, and the FAA is not equipped to respond to these challenges. The agency must cope with new technologies while maintaining high standards for safety, at a time where the availability of government resources is uncertain and demand from the aviation industry is high. The FAA must follow national and international best practices for establishing and adhering to risk-informed certification, shifting its paradigm from the current prescriptive certification system.

The FAA also needs to expand the use of delegation, a practice where the agency delegates certain discretionary functions, including certification findings to qualified persons, e.g.,

manufacturers. This will allow the agency to focus its limited resources on the areas that need the most attention from a safety perspective. To improve consistency in the application and interpretation of regulations and guidance, a body of government officials, labor representatives, industry employees, and independent experts should be established to collaboratively advise the agency on issues of safety and compliance, as well as application and interpretations of regulations. Similarly, certification and surveillance of repair stations should be streamlined to ease the burden on industry and government.

To implement such reforms, the FAA needs to work with the industry and focus on the outcome of its actions, measuring the impacts of the reforms it undertakes. It also needs to improve workforce education and training both in government and industry. These steps are critical for success, as the FAA will need a strong workforce capable of understanding systems engineering and collaborating with industry to advance safety. The focus on safety outcomes, rather than design, will also help the FAA cope with the demands for certification of new products and airspace users like drones and commercial space. These safety outcomes must be clearly defined.

Today, the FAA has a double mission. It is the provider of air traffic control and oversees the safety of the aviation industry, while also regulating itself as a provider. With an eventual spin-off of the air traffic control function, the agency can focus on its core mission: overseeing the safety of the national airspace. This is an inherently governmental function that should remain with the FAA. Freed of its role as an operator, the agency would be able to provide more effective certification, implementation, and safety oversight.

Overseeing safety is the most important role of the FAA and should be the focus of its efforts. While there is no doubt that the United States' stellar safety record is due, in large part, to the agency's establishing and implementing certification standards and oversight, action is needed today. As the FAA evolves to meet the new and growing demands from the expanding aviation sector, there is no better time to take steps that will ensure the American system remains the safest in the world and its industry the most competitive.

1. Introduction

The United States boasts the safest airspace in the world. Maintaining that level of safety is a top economic and social priority. Keeping the aviation sector safe means ensuring that the design, production, operation, and maintenance of civil aviation products and articles meet rigorous standards. Companies and workers—such as pilots, mechanics, and air traffic controllers—are thoroughly scrutinized to ensure adherence to these principles of safety.

The Federal Aviation Administration (FAA) at the U.S. Department of Transportation (U.S. DOT) is responsible for establishing, implementing and overseeing standards for design, production, operation, and maintenance. The role of implementation—known as certification—is critical and helps ensure public confidence in the safety of the system for business and leisure travel. The high level of aviation safety in the United States is the result of the continuous improvement by industry and government over many decades.

Safety certification also helps maintain strong demand for U.S. aviation products worldwide, not only for aircraft but also for maintenance and air traffic control modernization. Due in part to these high standards, aviation is a strong contributor to the American economy, responsible for $1.5 trillion in total economic activity, almost 12 million jobs, and 5.4 percent of the country's gross domestic product.[1] Within manufacturing alone, there are more than 1,600 civil aviation manufacturers who account for $75 billion in sales, and more than half a million direct jobs.[2] The aerospace industry's international trade surplus of $82.5 billion is the largest within the U.S. economy.[3]

Today, however, that competitive edge is under threat. Industry stakeholders, supported by significant research and analysis, have raised concerns about the efficiency and functionality of the FAA's certification and approval processes.[4]

To ensure the continued viability of the U.S. aviation industry, the federal processes must be flexible and able to respond to industry solicitations in a timely, efficient, and effective manner. Without a strong and agile FAA that can maintain, as well as improve, safety, the continuity of the U.S. aviation industry as a global leader is at risk.

While the FAA and Congress have worked to improve and streamline certification, the current processes remain inefficient and add unnecessary time and costs. Serious challenges exist, particularly with respect to delegating certain elements of the certification process. The FAA also fails in addressing government overseers' concerns in a timely and effective manner, and in measuring the impacts of the changes it implements.[5] The lack of consistency in applying and interpreting regulations and guidance for certification, oversight, and enforcement continues to be an issue between the agency and its certificate holders.[6]

Certification in the Context of Air Traffic Control Reform

This report highlights the issues identified with current certification procedures and recommends key policy reforms. It comes at a crucial time for U.S. aviation policy as Congress is actively considering reforming the FAA.[7] Most notably, these reforms include spinning off the nation's air traffic control (ATC) system to an independent, nonprofit entity. Regardless of the outcome of this initiative, one thing is certain: the FAA will still—and must—retain its role as the nation's top safety regulator. ATC reform will have the added benefit of relieving the agency from being both an operator and a safety regulator, allowing FAA to focus on its core mission of setting, implementing, and overseeing safety standards.

If the FAA is to stay abreast of new technologies and new demands resulting from these new technologies and a quicker pace of development, it must adapt by following national and international best practices for establishing and adhering to risk-informed, performance-based certification regulations and practices. It must also prepare its workforce, both current and future, for this new paradigm in certification processes.

Three areas of certification are the focus of this report:

1. *Aviation products (aircraft, engines, and propellers) and their components.* These products make up the physical backbone of the industry. They are a major source of American exports and of significant importance to the economy. The effective and efficient certification of new aircraft technologies is crucial in order for the United States to keep its leading role worldwide.
2. *Air traffic control and air traffic controllers.* ATC is a critical component of the aviation system, as it allows the safe operations of airlines and private aircraft. Considering the current problems resulting from the shortage of air traffic controllers, it is important to thoroughly examine the current system to determine where improvements can be made.
3. *Repair stations.* The places where airlines, general aviation, and commercial and business operators maintain their fleets have a crucial role in assuring the continuous safety of operations. The FAA's certification and oversight must ensure safety without hindering the services required by customers or that the market demands.

While many other areas of certification exist and are worth investigating, this report focuses on these three elements, which together make up a large portion of the FAA workload. These areas are also where future developments are most pressing.[8] It is important to note that these recommendations extend beyond the three areas listed above and may impact other areas such as unmanned aerial vehicles.

Research Sources

Some of the work presented in this report is based on informal and "off the record" candid conversations with stakeholders. Since some of those insights offered by the stakeholders are not available in the traditional literature on the issue, in a small number of instances throughout the report a traditional written source is not listed. However, in every case, the information presented is based on consistent and credible information.

The report's first section provides an overview of current aviation certification practices. The second discusses major issues related to certification, such as training and FAA culture. The third and fourth are international and domestic cases of how other countries and federal agencies perform certification duties. Then the report outlines a set of policy implications and recommendations for important reforms.

An accompanying document with two appendices explores how aviation certification is conducted in the U.S. in more detail. It presents a chronological literature review since 1980 of work that has analyzed, criticized, and proposed improvements to the way FAA conducts aviation certification.

2. Aviation Certification Today

Certification refers to the process in which applicants show—and the FAA finds—that products, personnel, and practices meet the standards required for integration in the national civil aviation system.

Certification is based upon regulations, most of which are set forth in Title 14 of the Code of Federal Regulations (CFR). These regulations are further enhanced by guidance material for the public and in more than 1,100 FAA internal orders directed at agency personnel.

This section provides a general overview of how FAA currently conducts the certification of aviation products, air traffic controllers, and repair stations. A more detailed technical description is available in the appendices present in the accompanying document to this report.

2.1 Aviation Products and Components

Civil aviation products undergo scrutiny to ensure that they are airworthy, meet an approved design, and are in a condition for safe operation. Before any aircraft, engine, propeller, component, or part can be used in civil aviation, its design and production must

be approved. This can take the form of a type or production certificate, a technical standard order authorization, or a parts manufacturer approval.

Approval is the responsibility of the FAA's Aircraft Certification Service's (AIR) team of approximately 690 engineers and 250 inspectors.[9] The FAA issues certifications and approvals for new products, components and parts as well as for changes in those articles. Components and parts include the avionics (electronic elements in the aircraft or aircraft engine) required for use in the modernized airspace under the federal Next Generation Air Transportation System (NextGen) program.[10] According to AIR, by the end of 2016, the department was working on over 7,500 certification projects, including almost 3,000 new and amended type certificates, and over 2,200 new and amended supplemental type certificates.

Aircraft certification has been the topic of many studies, some of which are discussed in the next section. While stakeholders generally believe certification achieves its safety goals, unnecessary approval delays, lack of appropriate delegation for activities not critical to safety, and inconsistency in applying and interpreting rules and guidance remain major challenges.[11] Since the 2012 FAA reauthorization, and following the recommendations of two committees created after that bill, the FAA has started to overhaul its certification procedures.

2.2 Air Traffic Control and Air Traffic Controllers

In its safety oversight role, the FAA develops rules and guidance on the administration of the ATC system. Air traffic controllers manage aircraft from take-off to landing (as well as when at the airport) to help make efficient and effective use of airports and skyways, and to avoid collisions. The ATC procedures and personnel must undergo certification to ensure safety and that the individual controller has the knowledge (through training and experience) to properly execute the approved procedures.

Different regulations apply to control tower operations at airports, to en-route centers that control airplanes at high altitudes, and to approach control near airports. Individual controllers must undergo both simulator and on-the-job-training, working under the close supervision of an approved instructor. After training, the controller must pass a set of exams and demonstrate the ability to properly apply ATC rules and regulations, thus assessing proficiency to do the job.

Stakeholders' primary concerns with the ATC certification process lie with training. For example, some facilities have too many trainees for the number of supervising controllers. This delays the ability of the trainees to work independently. The FAA is addressing the problem through better assignment of trainees to facilities, but the dearth of certificated air traffic controllers is a pressing and ongoing predicament.[12]

The FAA uses an internal certification process to ensure ATC equipment is capable of meeting operational needs. Given the ongoing proposals to spin-off ATC operations from the FAA, proper oversight of equipment certification is paramount. This will require an

appropriate regulatory framework with minimum equipment standards and oversight of such an entity's ability to perform required functions. Establishing, maintaining, overseeing, and improving a standalone ATC system will necessitate a paradigm shift for both the FAA, which is used to being both the operator and the safety regulator of the system, and the industry. The U.S. would not be the first country to reform ATC governance, and international experiences can help inform how to best approach the problem in the United States.[13]

2.3 Repair Stations

Certificates are issued to repair stations allowing them to conduct maintenance, preventive maintenance, and alterations on civil aviation products, articles or to perform specialized services. In the U.S., the repair stations' industry employs around 184,000 people.[14] Their certification is the purview of the FAA's Flight Standards Service (AFS). AFS is larger than AIR in terms of personnel, with around 4,000 inspectors certifying individuals and entities to operate and perform work on components of the national airspace system. These workers are spread across 100 field offices.[15]AFS certificates and oversees approximately 3,900 international firms.[16]

Special attention has been given to aircraft maintained by foreign repair stations. Under bilateral aviation safety agreements, certification and oversight responsibilities may be delegated to a foreign civil aviation authority. However, concerns have been expressed that foreign repair stations do not follow the same requirements and safety standards as U.S. locations, though the Aeronautical Repair Station Association disputes this.[17] Congress offers specific language relating to the oversight of foreign repair stations in most every FAA reauthorization legislation.[18]

Stakeholders' main criticism is the length of time repair station certification takes. The strain is particularly acute since repair stations cannot operate without the certificate and thus cannot service U.S. customers. Certification requires having appropriate housing, facilities, equipment, data, knowledgeable personnel, and materials. This demands significant financial investment for aircraft repair stations hoping to attract air carrier customers. On the other hand, certification of a foreign repair station in a country with a bilateral agreement depends upon the effectiveness and efficiency of its national civil aviation authority. If the foreign process is more efficient, U.S. leadership in aviation maintenance is threatened.

FAA processes applications based upon a first-come-first-serve priority and the evaluation is exactly the same for all types of applicants: general aviation to heavy maintenance for air carriers.[19] As such, the certification process is not based upon the type, extent, and nature of work contemplated by the application or on the knowledge, sophistication, and readiness of the applicant to show compliance with the regulatory standard.

Once certificated, repair stations complain that they are "over-audited" by the FAA, by the repair stations' customers (e.g., airlines), by the repair station customer's FAA representative, and by foreign authorities in cases where the repair station is certificated

by another country. These audits create a burden not only on the repair stations but also on the FAA, as much of the work is duplicated.[20] Repair stations argue that these audits could be streamlined and the different entities should be able to rely on a single, unified audit. The U.S. DOT's Office of the Inspector General (OIG) finds the "[FAA's] oversight emphasizes completing mandatory inspections instead of targeting resources to where they are needed based on risk".[21]

3. Certification Review and Reform Efforts

The FAA's ability to conduct efficient and effective certification processes has been a major focus of research for decades. There has been a particular interest in how the FAA certifies aviation products and oversees airlines'. This section provides background on several reviews of certification by the FAA. The appendices in the accompanying document to this report present a chronological literature review.

Product Safety

Ensuring that an aircraft, engine, or other product is safe to fly is the core of the certification work done by the FAA and the manufacturers. But the issue was especially important in the 1980s after a number of crashes revealed flaws in the way the FAA certified aircraft. A 1980 Congressional report concluded that "deficiencies in the certification process have and could continue to create serious hazards to aviation safety."[22] The report identified deficiencies in all three phases of the certification process:

1. During the *design phase*, the FAA was unwilling to question whether a manufacturer was improperly dismissing the risk of certain failures.
2. During *manufacturing*, the FAA did not ensure that the manufacturers had proper systems of inspections or quality control.
3. During the *flying life of the aircraft*, the report found that needed maintenance had been constantly postponed, quality control was ineffective, and personnel were poorly trained.

The report concluded that these issues stemmed from two fundamental problems. First, the FAA had become oriented to the needs of the industry, not the travelling public. Second, there was a lack of a coherent system to apply FAA's limited resources to the several stages of certification. Also in 1980, a National Research Council (NRC) report noted that there was some complacency during certification and advised the FAA to increase its emphasis on quality assurance, and make use of more inspections, including unannounced ones.[23]

More than a decade later, a report by the U.S. Government Accountability Office (GAO) also found major flaws.[24] The GAO concluded that the FAA delegated to the manufacturers many of its certification responsibilities (up to 95 percent in 1989, compared to 70-75 percent in 1980), while not assuring that its staff was effectively overseeing those activities or that they had the technical capabilities to perform that oversight.[25] And, while the

certification process had led to generally safe airplanes, that was largely due to the efforts, expertise, and high commitment to safety from the manufacturers. The contribution of FAA staff to those safety improvements was unclear. More recent reports have shown that these failures in terms of safety have mostly been resolved but other issues, highlighted below, remain.[26]

Staffing

The lack of training for FAA personnel has been noted as a problem at the agency for years. One of the first to highlight the issue was a 1980 NRC report that noted the lack of expertise at the FAA led to superficial technical oversight of product certification.[27] That report stressed that the FAA needed technical staff with greater levels of scientific competence, including in senior FAA positions. It also noted that this would require significant organizational changes.

Later in the 1980s the issue would come up again with the release of two GAO reports focused on delays in hiring new inspectors and challenges with training inspectors.[28] The challenge of hiring new inspectors was blamed on a hiring freeze resulting from Congress not appropriating funds for FAA operations on time, as well as a backlog in training at the FAA training facilities. Problems in training were mostly due to the fact that the FAA had to prioritize instruction for new hires, leaving current employees undertrained. In the early 1990s, the GAO still reported problems on this front and suggested that the FAA hire more experts and establish better training procedures for existing personnel.[29]

In 1996, a report by Booz-Allen & Hamilton for the FAA also discussed the issue of staffing. Mainly, the report argued that the FAA should change its hiring practices and prioritize hiring engineers and scientists (300-400 new hires in the short term), especially those with postgraduate degrees, instead of relying on technicians like they did at the time (and still do today).[30] This recommendation mirrored the one made in 1980 by the NRC.

In 2005, the GAO found the situation regarding technical training was much-improved, and concluded that the FAA has adopted many of the GAO recommendations on the issue.[31] Despite this, around half of FAA inspectors said they did not have the technical knowledge needed for their jobs. To this critique, the FAA responded that many inspectors sought competencies in areas not critical for their safety oversight role.[32]

Application and Interpretation of Regulations

The way regulations are applied and interpreted by the FAA has been a concern since at least 1980 and is now one of the most discussed issues in aviation certification.[33]

A 2010 GAO report found that while certification and approval procedures from both AIR and AFS were effective and contributed positively to aviation safety, differences in application and interpretation of standards were a concern for the industry, leading to higher costs.[34] The FAA had been implementing a quality management system—a mechanism that provides stakeholders a way to appeal FAA decisions—but lacked a way to

determine if the use of this system met the intended goal of reducing inconsistencies in the interpretation of certification regulations. In 2012, Congress mandated the creation of an Aviation Rulemaking Committee (ARC) to study the issue.[35] The committee identified three main causes for those discrepancies:

1. Unclear regulatory language that leads to inspectors and certificate holders applying them inconsistently;
2. Inadequate and nonstandard FAA and industry training also leading to applying regulations inconsistently;
3. Reluctance by both industry and the FAA to work out issues in interpretation, with fears of delays and retribution leading to inconsistent decisions.[36]

To address these problems, the ARC proposed a series of recommendations in two main areas: improve the uniformity of regulatory application by AFS and AIR, and improve the communication between those offices and the industry. The FAA responded with a six-item plan to address those recommendations. By March 2017, only two out of those six items have been completed, though the agency dropped one of them, as it was redundant with the others.[37]

Accountability and Culture

In 1996, GAO examined how the FAA responded to recommendations from outside entities such as Congress or government overseers like the GAO and OIG.[38] GAO concluded that while over the years the FAA generally agreed with the recommendations made by these different government watchdogs as well as other entities, the agency generally failed to implement those recommendations in a timely fashion. When responding to overseers' recommendations, the FAA also failed to provide completion dates which prevented Congress and government overseers from properly measuring the agency's progress. The GAO recommended that the Secretary of Transportation direct the FAA administrator to be more responsive, develop a timeline for implementation, and monitor FAA's implementation of recommendations, especially the ones that are most critical to safety.[39]

Later reports would highlight these issues again.[40] One of the issues identified is that the FAA usually responds to overseers' recommendations by implementing them within ongoing projects. Then, the agency alters these projects slightly, and reports that the recommendations have been implemented. Also, when the FAA marks an initiative as "completed", it merely means that the agency has finalized its work on the initiative. It does not mean that there are any observable impacts deriving from that recommendation or that it successfully addresses the initial goal of the recommendation.[41] Additionally, the FAA does not provide measurements of efficacy, leaving overseers and the public without an understanding of whether changes are taking place and the impact, or lack thereof, that they are having in improving the agency's processes.[42]

Agency culture was a major component of the 2008 *Blue Ribbon Panel on FAA's Approach on Safety*.[43] This commission was created following allegations that the FAA had known about maintenance issues with some Southwest Airlines aircraft but had failed to act on

them. The panel stressed the importance of FAA's voluntary disclosure programs, stating that they should be retained and the employees should be incentivized to make use of them.[44]

A 2013 GAO report also discussed how cultural factors at the FAA were preventing the agency from implementing previous recommendations from Congress and the Mineta Commission.[45] A 2017 report from the GAO voiced similar concerns.[46] For the GAO, implementing those recommendations required a cultural change in the FAA's workforce and the resistance to a different approach within the agency continued to be an issue.[47]

Recent Developments

The two most significant reforms that the FAA has undertaken recently have been the reorganization of their delegation programs, and the adoption of new methods to prioritize projects. The agency is also restructuring the organization of AIR, the office responsible for product certification.

In 2005 the FAA consolidated existing organizational delegation types into a single regulation, the Organization Designation Authorization (ODA). Under this umbrella, the FAA delegates certain discretionary functions to qualified organizations. The delegation authority allows these private entities to perform certification functions on the agency's behalf, including approving new designs for aircraft and components. In 2016, around 80 companies, including major design and production certificate holders such as Boeing and Rockwell Collins, had this authority.[48] According to FAA officials, 90 percent of certification activities are now conducted through the delegation programs.[49]

After ODA was implemented, the OIG recommended that the FAA improve oversight, including better monitoring of ODA personnel and training of agency engineers assigned oversight responsibilities.[50] ODA oversight is conducted by the same 700 engineers and 250 inspectors that are responsible for 1,600 manufacturers, including the 80 with an ODA.

One of the ARCs created by the 2012 FAA reauthorization bill concluded that the ODA program was making the certification processes more effective and efficient.[51] Still, this ARC highlighted that these key benefits of ODA have not been not fully realized because of the slow transition to a systems approach to certification. The ARC recommended that the agency had to ensure that appropriate training and resources be available to improve the ODA program. It further noted that the FAA could maintain robust oversight by creating teams and/or individuals with specialized training to conduct ODA audits. The ARC also recommended the expansion of delegation to include support for all certification activities when appropriate, particularly low-risk or routine activities such as noise and emissions tests.[52]

In addition to revamping the FAA's delegation system, in 2005 the agency introduced project sequencing to prioritize certification submissions. Through this system, resources were to be allocated based on several criteria, including safety attributes and their impact on the air transportation system.[53] New applications for certification expected to require

more than 40 hours of FAA involvement were placed into the program. The FAA then took approximately 90 days to determine whether a project could begin.[54]

Project sequencing was discontinued in 2014 and was replaced with the AIR Project Prioritization and Resource Management program. The goal of the new project prioritization program was to make the process more predictable and transparent which, in turn, helps the agency and applicants schedule accordingly. It also aimed to increase early and continuous communication between the FAA and applicants on topics such as the risk-based level of involvement, safety index, and project priority.[55]

The new project prioritization program allows the applicant to work on the project elements even if the FAA does not have resources available or for which FAA action is not required. This is unlike the previous model where the FAA delayed the entire project until agency resources were available. The new program also allows for shared resources across AIR offices to complete tasks in a more efficient manner.[56]

Under the current program, projects are evaluated according to set criteria based on the safety impact of the project, with very high and/or more immediate safety benefits getting the highest ratings. The size of the aircraft is also taken into consideration, with large aircraft getting higher ratings for prioritization. The size of the fleet potentially affected is also considered, as is the number of applicable regulations and the use of designees.

The FAA has started a process to restructure its AIR office from a product-based structure (small airplanes, rotorcraft, etc.) to a functional one with five divisions (policy, compliance and airworthiness, system oversight, organizational performance, and enterprise division). FAA intends to finish this reorganization by the end of 2017.[57]

The agency's goal with the AIR reorganization is to increase the efficiency and effectiveness of the certification processes, and to address stakeholder expectations. On this latter point, FAA says the new structure will allow the agency to work with the industry earlier in the development of new products, streamlining the certification process and making it more consistent.[58]

The 2016 FAA reauthorization extension was largely silent regarding certification.[59] Although they were not part of the extension, the long-term bills that were under discussion in the House and the Senate before did address key reforms to the certification process.[60] Both bills proposed the creation of a Safety Oversight and Certification Advisory committee that would advise the FAA. The committee would be governed by a set of stakeholders, including general and commercial aviation, labor, manufacturers, the unmanned aerial system industry, and the public. The bill also directed the FAA Administrator to "establish performance objectives and apply and track metrics for the FAA and the aviation industry relating to aircraft certification". In an effort to reduce discrepancies in the interpretation of delegated functions, the bills also created an ODA office, with the purpose of overseeing and ensuring the consistency of FAA's audit functions under the ODA program. While these measures were not included in the extension passed in 2016, given that they enjoyed

bipartisan support, it is expected that they will be up for discussion when a new FAA bill is put before Congress.

4. International Certification Practices

This section analyzes two international certification systems. The first focuses on ATC certification in Canada where the system is operated by a private entity. The second analyzes how aircraft certification is conducted by the European Aviation Safety Agency (EASA).

Air Traffic Control: Canada

Since 1996 ATC in Canada has been provided by NAV CANADA, an independent, private, nonprofit user co-operative. NAV CANADA is responsible for the second busiest airspace in the world, with roughly one-seventh of the traffic volume of that of the United States. NAV CANADA employs around 4,600 people, out of which 1,850 are air traffic controllers.[61] In 2016, it had revenues of more than USD$1 billion.[62]

Safety oversight of the ATC system remains the responsibility of Transport Canada, a federal agency. While most of the certification work—including training and examining air traffic controllers, and putting new equipment into operation—is delegated to NAV CANADA, Transport Canada performs a number of scheduled and unscheduled audits at NAV CANADA facilities.

Transport Canada allocates USD$1.55 million (which is around 2 percent of the agency's budget for all civil aviation activities) and around 20 dedicated employees to overseeing the ATC system. NAV CANADA must maintain a safety management system (SMS), including an independent "Office of Safety and Quality." The safety management system requirements include, among others, the need to perform internal audits and to articulate and track performance goals along with metrics.[63]

Ultimate licensing responsibility for individual certificated air traffic controllers remains with Transport Canada. However, theoretical and practical training and examinations are done by NAV CANADA on the government's behalf. Transport Canada approves the training programs to ensure they meet the intentions of the regulations, and it audits and evaluates the entire process.

NAV CANADA is independent in implementing and installing new equipment, and its personnel, including air traffic controllers, conducts certification internally. Current and former air traffic controllers are also involved in software development, as NAV CANADA makes much of the software it uses in-house. Transport Canada's role it is to ensure NAV CANADA complies with relevant Canadian regulation and with the standards set forward by the International Civil Aviation Organization (ICAO).

Stakeholders note that the relationship between NAV CANADA and Transport Canada is one of mutual transparency and open conversation enabling a clear understanding of each other's mandate. Transport Canada has access to all documentation related to NAV CANADA's operation, and offers an "external set of eyes" to make sure all safety precautions are correctly implemented.

Aircraft Certification: Europe

EASA is an agency of the European Union with the responsibility of issuing type-certificates for the 28 European Union countries plus Liechtenstein, Norway, Switzerland, and Iceland. While EASA was established in 2003, aircraft certification has been based upon mutually recognized European-wide standards for three decades. In 1987 the Joint Aviation Authorities (a coalition of many of the European civil aviation authorities) provided standardized language for adoption by individual European countries' national aviation authorities. In 2016 EASA had a budget of US$190 million, with 55 percent coming from user fees. The rest comes mainly from contributions by the countries that are part of EASA.[64]

The way EASA performs its design and production certification duties is different from the FAA, especially during the production period. The FAA relies heavily on its own staff and expertise to oversee the entire certification process, even in the cases where discretionary certification elements are delegated, while EASA delegates most certification work to designers and producers. This is done via the Design Organisation Approval (DOA); while similar to the FAA's ODA program, it is broader in scope, giving qualified manufacturers more authority to make findings of compliance. However, EASA also mandates that each organization must have a DOA before it can request a type certificate. Since EASA charges fees for an organization to have a DOA, this creates a barrier to entry in the market. By the end of 2015, there were around 300 companies with an EASA DOA.[65] By comparison, in the U.S. there are around 80 companies with an ODA.

The manufacturers with delegation are still overseen by EASA. But oversight differs from the way the FAA works, as EASA uses a risk-informed approach. Instead of verifying every step of the design process, EASA focuses its oversight on the most critical safety areas, like new technologies (e.g., new materials or processes like additive manufacturing). EASA also relies extensively on the national authorities to provide oversight of production after a type certificate is issued for a given product.

This system safety methodology has its roots in the German certification procedures from the 1960s. At the time, the German civil aviation authority (Luftfahrt-Bundesamt) lacked the resources to implement a hands-on oversight system. Instead it leveraged the industry's knowledge, creating risk-informed requirements with extensive use of delegation, allowing for "self-certification." This was contingent on the applicant or certificate holder having a sophisticated risk-informed management system.

EASA charges fees for both obtaining and maintaining a type-certificate. Table 1 highlights some of the fees to certify aircraft.

Table 1. EASA fees for aircraft certification.

Type of Aircraft	Initial Fee	Annual Fee
Light Sport	$5,500	$850
Up to 4,400 lbs.	$15,000	$2,500
4,400 to 12,550 lbs.	$280,000	$5,000
12,500 to 48,500 lbs.	$410,000	$45,000
48,500 to 110,200 lbs.	$545,000	$275,000
111,200 to 330,700 lbs.	$1,650,000	$910,000
Over 330,700 lbs.	$1,900,000	$1,150,000

Source: European Commission, "Commission Regulation (EU) No 319/2014 of 27 March 2014", 2014.

To be designated as a DOA, manufacturers have to pay an approval fee, plus an annual fee based on the number of employees at the organization. Table 2 lists some of the corresponding fees.

Table 2. EASA fees for organization with a Design Organisation Approval.

Number of Employees	Approval Fee	Annual Fee
Less than 10	$14,500	$7,250
10 to 49	$41,000	$20,500
50 to 399	$117,000	$58,000
400 to 999	$233,000	$117,000
1,000 to 2,499	$466,000	$233,000
2,500 to 5,000	$700,000	$350,000
Over 5,000	$3,900,000	$1,950,000

Source: European Commission, "Commission Regulation (EU) No 319/2014 of 27 March 2014", 2014.

Stakeholders claim that parts of the European certification system are more efficient than the American model and achieve similar safety results.[66] This may be especially true during the production stage, where EASA only gets involved when major changes to the original design are implemented. Indeed, many of the recommendations made by ARCs and directives from Congress are based upon the European certification risk-informed system. However, stakeholders maintain that the FAA should not restrict the companies that can apply for a product approval like EASA does.

Stakeholders, including in Congress, disagree with the fee collection by EASA.[67] This is due to a number of reasons, namely, that manufacturers already spend a considerable amount of resources doing certification work and are loathe to pay more, especially for parts that are certified in the United States. Plus, EASA's fees are not related to cost or performance, thus not creating incentives for improvements in certification procedures.

5. Certification By Other Federal Agencies

The FAA is not the only federal agency that conducts product, personnel, and operations certification. This section examines five other federal agencies' certification processes. Two are from the transportation sector: the Federal Railroad Administration (FRA) and the National Highway Traffic Safety Administration (NHTSA). Two administer risk-informed, performance-based certification: the National Aeronautics and Space Administration (NASA) and the Nuclear Regulatory Commission. One charges its customers user fees for certification: the Food and Drug Administration (FDA).

Food and Drug Administration

The FDA is the federal agency responsible for guaranteeing the safety of food, cosmetics, medical devices, and pharmaceutical drugs, among other things. It is part of the U.S. Department of Health and Human Services, with a budget of $4.7 billion in 2016, from which $2.0 billion came from user fees and the rest from the General Fund.[68] User fees fund the evaluation of new pharmaceutical drugs to determine whether they are safe and effective for the intended use.

With the passage of the Prescription Drug User Fee Act (PDUFA) in 1992, Congress intended to reduce the backlog in drug applications and shorten the time between initial application and approval. In the late 1980s, it took an average of 29 months to get a new drug approved by the FDA. The FDA had been requesting the authority to charge user fees but the industry was opposed, fearing user fees would be used to fund the overall government, not just drug applications. To assuage those fears, the five PDUFAs enacted since 1992 have limited what user fees could fund, and limited their usage to activities related to the drug approval itself. Performance goals and targets were also established.[69]

The revenues from user fees allowed the FDA to add around 2,000 full-time employees which helped in reducing review times. In 2015, the agency was on track to meet or exceed most PDUFA goals and it took them an average of 8.5 months to approve a new drug.[70] In 2002 the GAO studied PDUFA outcomes and concluded that "PDUFA has been successful in providing FDA with the funding necessary to hire additional drug reviewers, thereby making new drugs available in the United States more quickly." At the time, drugs took an average of 14 months to get approved. However, the report concluded that the percentage of drugs retired from the market for safety-related reasons had increased since PDUFA's enactment.[71]

A 2007 study suggested that PDUFA resulted in social benefits in the order of $1.4 billion to $25.4 billion between 1998 and 2002. These include both the positive benefits of having new drugs on the market and the detrimental effects of having new, potentially unsafe, drugs commercialized too quickly.[72] Still, the FDA case is an example where additional funding from user fees provided increased resources to reduce approval timelines.

Federal Railroad Administration

FRA, an agency within U.S. DOT, is responsible for overseeing the safety of the nation's public and private railways, as well as promoting a reliable and efficient movement of goods and people.[73] In FY2016 it had a budget of $1.7 billion.[74]

The FRA sets forth the minimum safety standards but does not perform certification of either the physical infrastructure of the railroads, nor the rolling stock (locomotives, etc.). Certification is left for the railroads themselves or the manufacturers. Sometimes there are courtesy inspections by the FRA but those are not necessary for a railroad to operate a track or a new piece of equipment. Much like with automobile makers, the manufacturers are responsible for complying with the federal regulations.

There is, however, a key piece of equipment that the FRA is responsible for certifying: Positive Train Control (PTC). PTC is a communications and signaling system that will allow for increased safety by enforcing movement restrictions, including speed limitations, should the crew fail to do so. There is currently a Congressional mandate to implement PTC in a large portion of the U.S. rail network by the end of 2018.[75] The FRA is responsible for certifying both the equipment and the railroads' plan to implement PTC. The mandate for PTC came into effect after a series of crashes suggesting that additional oversight was needed to ensure safety on the rail network.

The FRA also performs certification of locomotive engineers (since the 1990s) and conductors (since 2012). Engineers are the people actually operating the train, while conductors are required to ensure that operating rules and instructions are obeyed and that hazardous materials information is correct and available to responders, among other duties. While under the purview of the FRA, the certification of these individuals is devolved to the railroads. These companies train and license engineers and conductors themselves (the smaller companies might use contractors), with the FRA being responsible for oversight of the entire process, including the setting of standards and the inspection of records.

Following a number of crashes in which the medical conditions of the railroad workers was determined to be a cause, the National Transportation Safety Board (NTSB) recommended multiple times that the FRA develop a medical certification for employees in safety-sensitive positions. This would be similar to the manner in which the FAA certifies the health conditions of pilots. Despite researching the issue for over 15 years the FRA never implemented such a measure. [76]

Much like in aviation, rail stakeholders have pressed the agency towards more flexible, performance-based standards and requirements, instead of the current prescriptive

regulations. The FRA offers a "hands-off" approach to certification that is less palatable in aviation, for industry, government, and the public, leading to few similarities between the two agencies.

National Aeronautics and Space Administration

NASA is the federal agency responsible for the United States' civilian space program as well as aeronautics and aerospace research.[77] In FY2016, its budget was $19.3 billion.[78]

NASA's missions are unique as they are very low volume and high cost, with levels of risk that most industries probably never face. As such, NASA needed to develop ways to assess and mitigate those risks. NASA, like the Nuclear Regulatory Commission, has been dealing with this problem by certifying its "products" using probabilistic risk-informed assessments.[79]

NASA started conducting probabilistic risk-informed assessments following the fire on Apollo 1 in 1967 that killed three astronauts. The results at the time were believed to be too pessimistic and the use of risk-based assessments was discontinued for a few decades. The Challenger space shuttle disaster in 1986 revived the method for the agency and NASA turned to the Nuclear Regulatory Commission for help in developing their risk analyses.[80] Efforts to use risk-informed analysis widely at NASA began in the early 2000s.[81]

Risk is defined as encompassing all possible undesirable consequences in a given project and the probability of occurrence of undesirable consequences. To assess that risk, three questions should be answered: what can go wrong, how likely that it will go wrong, and what are the consequences.[82] The risk-informed analyses are used to complement and not substitute more deterministic and traditional engineering methods.[83] The use of risk-informed methods has the objective of identifying and assessing the hazards in NASA's complex technological systems in order to improve safety and performance in a cost-effective manner.[84]

The use of risk-informed and performance-based certification for the FAA has been proposed before[85] and will be in use starting in mid-2017 for smaller, "Part 23," aircraft.[86] The way NASA and The Nuclear Regulatory Commission have been applying those methods, although in different environments, offer lessons on how to proceed.

National Highway Traffic Safety Administration

NHTSA, also housed in U.S. DOT, is the agency responsible for developing, establishing, and enforcing the Federal Motor Vehicle Safety Standards (FMVSS), which were first established in 1967. NHTSA also licenses vehicle manufacturers and importers, enforces the federal regulations on fuel economy, and tests vehicles for compliance with the safety standards.[87] In FY 2016, it had a budget of $869 million.[88]

Although NHTSA is responsible for enforcing the safety standards, the agency is not responsible for certifying that a vehicle complies with all applicable FMVSS before the

vehicle is produced. The manufacturer has that responsibility to assure compliance and self-certifies its products. The FMVSS establish the minimum performance requirements, and the manufacturers may produce and sell vehicles that go beyond those basic standards. Additionally, the manufacturer does not even have to report to NHTSA information about whether its products comply with applicable regulations.[89] However, in the ongoing discussions regarding automated vehicles, NHTSA has indicated that it might seek Congressional authority to pre-certify vehicles' automated driving systems before they are allowed to be operated on public roads.[90]

Still, NHTSA's Office of Vehicle Safety Compliance can test vehicles for adherence to safety standards. The office performs a series of annual tests that selects vehicles available for sale to the public and tests them according to the applicable FMVSS. NHTSA also monitors consumer complaints about vehicles for evidence of safety defects that may necessitate a vehicle recall.[91] NHTSA has been criticized for not properly using the data that it collects (from manufacturers, testing, and crashes) and for being slow in keeping pace with new technologies.[92]

Much like the FRA, NHTSA's certification is mostly devolved to the manufacturers, a paradigm that probably would not be acceptable for aviation. In this way, the lessons for FAA that can be learned from NHTSA are limited.

Nuclear Regulatory Commission

The Nuclear Regulatory Commission is an independent federal agency responsible for "[ensuring] the safe use of radioactive materials for beneficial civilian purposes while protecting people and the environment."[93] By regulating commercial nuclear power plants and other uses of nuclear materials, such as in medicine, the agency ensures that such operations minimize risks for public safety and health.

The agency was formed in 1975 after the nuclear sector was reorganized. Before that, the Atomic Energy Commission (AEC) was not only the safety regulator, but also performed research and development (R&D) for the nuclear industry. In 1975 these functions were split into two separate entities to prevent potential conflicts of interest: the Nuclear Regulatory Commission for safety regulation and the Energy Research and Development Administration (merged into the Department of Energy in 1977) for R&D.

With a budget of $1 billion for FY2017,[94] the Nuclear Regulatory Commission, like NASA, makes use of "risk-informed, performance-based" assessments in its certification of equipment and procedures for the nuclear industry. [95] The Nuclear Regulatory Commission first began testing risk-informed regulation in the 1970s, but its use was limited due to constraints in computing power as well as an unwillingness of the agency to deviate from the well-known deterministic methods used at the time.[96]

In the 1990s the agency began an extensive move toward becoming risk-informed. Today, the main analytical tool by the agency is a statistical risk assessment method called Probabilistic Risk Assessment (PRA).[97] This method is used to support decisions related

to nuclear reactor design and operation based on a series of metrics. In essence the PRA measures what can go wrong, the likelihood of failures, and their consequences.[98] One of the potential problems with this approach is the lack of accurate data, an essential component in any risk analysis.[99]

The goal of using risk-informed regulation is to reduce unnecessary burdens and costs without reducing safety. This allows the agency and relevant operators to focus on the areas that are more important to the safety of the nuclear operations and allocate resources accordingly.[100]

In addition to studying regulations from a risk-informed perspective, the Nuclear Regulatory Commission also uses performance-based regulations that allow operators to achieve a certain objective, or safety goal, without the Nuclear Regulatory Commission having to prescribe how. The focus is on the outcome, not on the process.[101] Stakeholders have expressed their interest in moving the certification processes at the FAA towards that paradigm.

Similarly, the International Atomic Energy Agency has put forth guidelines for the use of risk-informed, performance-based regulations.[102] After a long transition period where the Nuclear Regulatory Commission evolved into using more and more risk-informed assessments and requirements, since 2007 every application for a new nuclear reactor requires the operator to submit a plant-specific PRA to the Nuclear Regulatory Commission as part of the application.[103]

The Nuclear Regulatory Commission is a suitable model to consult if and when the FAA decides to move to a similar system. The Nuclear Regulatory Commission can leverage its scientific and institutional knowledge to assist the FAA in implementing the risk-informed, performance-based certification processes desired by industry.

6. Implications and Policy Recommendations

Updating the certification processes at the FAA poses a variety of challenges. The agency must cope with rapidly changing technologies while maintaining standards of safety. This is not an easy task for the FAA, as uncertain government resources might not keep pace with a growing and evolving aviation industry.

However, there are opportunities for the FAA to improve. It should learn from its national and international peers and adjust its methods to safely integrate more aviation products in the national airspace, while preserving high levels of safety.

All recommendations follow the premise that safety oversight is an inherently governmental functional that should remain in the hands of a government entity. However, this does not mean that the FAA cannot work closely with industry in advancing safety. Instead, it should maintain decision-making power while engaging industry expertise and resources.

Funding for Certification

It is important to note that these policy recommendations do not address funding. Traditionally, funding for the FAA has come from two sources: general funds and taxes on the aviation system (fuel taxes, passenger ticket taxes, etc.), with the latter comprising the majority. There have been discussions of moving ATC to a user fee-based funding system, but this argument has not fully saturated the discussion over certification funding. The industry is largely opposed to the FAA implementing user fees for certification, citing EASA as an undesirable example where user fees do no relate to the cost of provision or performance by the agency.

6.1 General Principles for Reform

Focus on the outcome, not on the output.

Instead of focusing on compliance with prescriptive government mandates (the output), the FAA needs take into consideration the impacts of the requirements (the outcome). When directed to implement a suggestion from an outside entity, the FAA has a habit of demonstrating responsiveness through slight modifications to ongoing projects. The agency then reports to government overseers that the recommendations have been implemented and closes the case. That needs to change. Input and advice from stakeholders deserve serious consideration. As the GAO and OIG have suggested multiple times, metrics need to measure the impact of the proposals and implementation measures. Only then can the FAA ascertain that it is indeed following those recommendations and both the agency and the industry can reap the benefits of the improvements. This has been done at other federal agencies, like the FDA, where performance metrics were established to ensure that the payment of user fees was leading to quicker certification processes.

Create an Aviation Certification Exchange (ACE) to advise on best practices.

FAA and industry need to work together to advance safety while developing and implementing the best innovative certification procedures. The Commercial Aviation Safety Team (CAST) presents a prime example of what collaboration can bring. Created in 1998, CAST is data-driven; industry and government work together to reduce the fatalities in commercial aviation. From 1998 to 2008 the fatality risk for commercial aviation in the United States was reduced by 83 percent. The goal from 2010 to 2025 is a further 50 percent reduction.[104] This example shows what can be achieved when clear goals and roles are set. While there are risks of blurring the regulatory relationship, this volunteer group shows how both a regulator and a regulated industry can collaborate to advance aviation safety.

The same collaborative methods should be used to improve other areas, including certification. The FAA should establish a public/private group called the Aviation Certification Exchange (ACE) where industry and government regulators can share knowledge related to certification in a collaborative fashion and set bold—but realistic—and measurable goals to improve certification processes.

Standardize technical education when possible.

Ongoing education, especially on new technologies and systems approaches to certification, allows for the FAA workforce to be more prepared and better work with industry partners. According to stakeholders, the two-week course the FAA currently delivers for its own employees and industry workers is general in nature and not engineering-specific.

Additionally, each company with an ODA is required to have some type of training program. However, the FAA does not currently assess the quality of that training. The FAA should develop standardized education and testing of certification engineers and inspectors in order for everyone to be trained at least on the same core knowledge areas. Those core areas should be defined by ACE, Eno's proposed public/private advisory board. With this, FAA certification engineers would have a defined program for obtaining and maintaining the specialized knowledge needed to effectively establish, implement and apply standards, and oversee aircraft certification projects.

6.2 Area-Specific Policy Recommendations

6.2.1 Product Certification

Move to a risk-informed, systems engineering product certification system where a clearly defined safety outcome is the goal.

The FAA needs to focus on risky components when certifying products and develop holistic approaches that allow it to concentrate attention on the safety outcomes rather than on the procedural aspects of designing or manufacturing a product. The nuclear industry regulators have shown how these approaches can be used to direct agency efforts to critical areas. The FAA needs to learn and deploy similar methodologies in both product and repair station certification.

Use performance-based regulations and standards.

The role of the FAA should not be to determine what a product is to look like. Its role should be to make sure that a product achieves a certain safety performance level. As long as a product meets the safety standards, a manufacturer should be able to achieve the result in any way it sees fit. The FAA has already moved toward such a system for smaller (Part 23) aircraft. It should continue those efforts, evaluate their benefits and drawbacks, and adopt new measures for more products. While there is some concern about the safety implications of performance-based standards, their use allows for more (potentially safer) products to

be certified. The flexibility of performance-based standards also allows for innovations in technologies, which might not be approved under prescriptive-based regulations, to be put on the market. While acknowledging that performance-based regulations and standards are easier achieved for low-risk areas, the FAA needs to work toward that paradigm for the majority of its certification procedures.

Clarify the position on Safety Management Systems.

SMSs are organization-wide safety policies, with formal methods for identifying hazards, controlling and continually assessing risk, and promoting a safety culture.[105] If used properly, they drive collaboration and can identify and address safety issues before unsafe conditions are created. They are also essential for organizations that seek extended delegation power. The FAA should clarify what types of organizations require an SMS and what the policies should consist of. The rules must be written so they can be enforced.

Expand the use of delegation.

The FAA needs to focus its limited resources on the areas of safety that need the most attention. Although it will always need to apply appropriate controls and oversight, many lower risk items can be delegated to qualified companies, and the FAA should identify the particular aspects that it cannot delegate (e.g., new technologies with significant safety implications). When functions are delegated, each entity's role must be clearly defined.

However, no one should be required to have delegation authority if it is not wanted. Additionally, the FAA should ensure that there is proper oversight and that it has qualified individuals to audit high-risk certification areas. Additional resources or reassignment of current resources by the FAA might be needed if the workforce is not in the right places for such a shift. Moreover, this change in paradigm will require more specialists at the FAA who can better understand systems engineering, not just strict compliance to prescriptive regulations. This will require changing hiring practices focusing on engineers and scientists, creating a workforce not only proficient in well-known tasks but also ready to deal with new and unexpected situations in the future.

Create a body to advise the FAA regarding the inconsistent application and interpretation of regulations.

The FAA should establish an advisory entity, composed of federal government officials, labor representatives, and industry representatives, as well as independent experts when needed. This group would collaboratively advise the agency on issues of safety and compliance, as well as application and interpretations of regulations. There should be a permanent commission that would request external help from experts as new issues emerge. This could either be the same as the ACE proposed above, a subcommittee of that entity, or a different entity altogether, like the new Regulatory Consistency Communications Board, proposed by a recent ARC.[106] Whatever form it may take, the group needs to reach answers quickly, and the FAA should take its advice and deliberations seriously. In other words, it should not be an advisory body that the FAA views as a burden.

6.2.2 Other Areas

When certifying new airspace products or users like drones, focus on the safety outcomes, not the design.

Unmanned aircraft systems and commercial space operations are here and will not go away; they will only get bigger and more prolific. The FAA has already developed rules for the integration of small (under 55 pounds) unmanned aircraft into the national airspace.[107] Yet for commercial space, there is currently a moratorium that prohibits the FAA from regulating the safety of vehicles and crew of commercial space activities in the same manner as transport aircraft until 2023.[108]

In either case, the FAA will eventually be involved in certifying products and operations. The FAA must not let itself fall into the tradition of mandating designs. Instead, it should work with the industry to develop performance standards that allow drones and space vehicles to safely operate and integrate into the national airspace, while allowing innovative solutions that account for technological advances.

Prepare for major ATC reform.

The spin-off of ATC is a possibility for which the agency must prepare. Several areas in particular deserve attention. First, the risk of fragmenting safety oversight between the FAA and an eventual ATC provider merits caution. Each entity should have well-defined roles and lines of communication should be permanently open to solve issues and avoid fragmentation.[109] The provider will assure safety, while the FAA will oversee it. Second, the FAA should find ways to retain specialists and avoid a "brain drain" to the ATC provider. Internal experts will be needed to ensure a smooth transition and proper ongoing oversight.

Use risk-analysis in the certification of repair stations.

The type and amount of work a repair station can, or will, do has different impacts on safety. Maintaining galley equipment is not the same as repairing an engine. The FAA should acknowledge the differences and base its certification procedures on what potential safety impacts the prospective repair station will have. Prioritizing accordingly will free up resources at the FAA, as inspectors will spend less time with some applications, allowing them to focus on more safety-crucial activities.

Establish a unified audit of repair stations.

Repair stations are subjected to a plethora of audits. Without jeopardizing the FAA's prerogative to conduct them, there should be a system upon which each entity auditing a repair station could rely on a single, unified audit that can satisfy their oversight needs. This would ease the burden on industry and government. Clearer rules and instructions on what a repair station must do after an audit are also needed. This would avoid situations where the repair stations do not perform needed actions timely because of misinterpretation of audit results.

7. Conclusion

The U.S. aviation industry faces a number of challenges. In the short term, the industry must be able to supply a growing global demand for aerospace products and services or it faces the risk of losing business to other parts of the world. While certification is only one aspect of that challenge, it is of extreme importance as it ensures public safety.

In the long term, the industry must be able to introduce new technologies in the face of increasing competition from abroad. The types of technologies entering the market is also changing. New developments in software and artificial intelligence,[110] along with a faster development cycle, will result into more products being introduced at faster rates into the market, increasing FAA's workload. To keep its international edge, the U.S. aviation industry must introduce valuable, cutting-edge products and services. That means the FAA's certification and approval processes must be efficient and effective, maintaining and improving the level of safety.

Ultimately, the United States needs a simple, but not simplistic, aviation certification system. As *The FAA and Industry Guide to Product Certification* states, there should be "clearly defined and understood roles, responsibilities, and accountability of all stakeholders."[111] The entire certification system needs to allow rule changes to be done quicker and focus not on administrative processes, but on collaboration and engineering safety analysis and oversight. The rules must be clear and when doubts on application or interpretation arise, there should be mechanisms for swift resolution. The goal should be to move towards the implementation of risk-informed, performance-based standards for both new and existing users in the nation's airspace.

With this, the nation will have a safety oversight system more prepared for the challenges that the next decades will bring.

8. Endnotes

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CONTACT US:
1710 Rhode Island Ave., NW Suite 500
Washington D.C., 20036

publicaffairs@enotrans.org
202-879-4700
@EnoTrans