Testimony of
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on

The Federal Aviation Administration's Flight Plan: Examining the Agency's Research and Development Programs and Future Plans

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Chairman Babin, Ranking Member Sorensen and Members of the Committee, on behalf of the employees of Raytheon Technologies and its Collins Aerospace business, I want to thank you for the opportunity to share some thoughts today on an issue that is at the forefront of our company and the entire U.S. aerospace industry: the research and development (R&D) programs that will define our next-generation aircraft to make flight more efficient, more sustainable and more affordable while improving safety and reducing noise and emissions.

As I look across the roster of this subcommittee, I'm pleased to note that Collins has major facilities either in or near the districts of every single member – from our business center in Rep. Jackson's district in North Carolina, our commercial avionics site in Rep. Posey's district in Florida, our Army Aviation Customer Experience Center in Rep. Strong's district in Alabama as well as our many sites in southern California, New York, Georgia and Colorado.

It's a particular privilege to represent a company with major facilities in both the chairman and ranking members' congressional districts. We appreciated having Chairman Babin with us at the launch of the Collins Houston Spaceport site that we opened last summer. This new facility that will help build the next generation of spacesuits for NASA, as well as other human spaceflight systems for use on the International Space Station, future Low Earth Orbit platforms and on the moon as part of the Artemis missions.

Similarly, Ranking Member Sorensen represents the Collins site in Rockford, Illinois, where I have the honor of serving as the site leader on behalf of our more than 2,000 employees working in our Power & Controls, Mission Systems and Advanced Structures businesses. This site began as the headquarters of the Sundstrand Machine Tool Company, founded in 1926, and played a major role in World War II developing products for aviation that resulted in the Sundstrand Aviation division. In 1999, Sundstrand merged with Hamilton Standard, an aircraft propeller parts company, which later merged with Goodrich and Rockwell Collins to form Collins Aerospace in 2018. Today, the site is the heart of the Collins Electric Power Systems (a part of Power & Controls) business, which produces a variety of systems such as generators and emergency power systems for commercial and military aircraft. To help reduce emissions in future aircraft, the site is also developing hybrid-electric propulsion systems with our sister Raytheon business Pratt & Whitney.

As the Congress begins its work drafting the FAA Reauthorization Act of 2023, I appreciate this Committee's role in providing oversight and developing the R&D authorization as part of this effort. While the FAA is a large agency that serves many critical roles in the areas of certification of aircraft and UAS, air traffic management and commercial space - among many others - its R&D programs play an important role in advancing technologies that may demonstrate significant improvements in efficiency, sustainability, safety and noise reduction and that have major impacts on communities and passengers.

For over a century, U.S. industry has played a leading role in developing the technologies that led us from first flight to supersonic flight and everything in between. The U.S. aviation industry helped establish successful commercial markets for passengers and cargo while making significant generational leaps in improving safety and reducing emissions and noise. This has also resulted in aviation being one of the last areas where the U.S. enjoys a positive balance of trade and major exports both for aircraft as well as parts and components for U.S. aerospace suppliers like Collins and our industry partners. According to the International Trade Administration (ITA), "The U.S. aerospace sector continues to produce the highest trade balance ($77.6 billion in 2019) and the second highest level of exports ($148 billion) among all manufacturing industries."[1]

Raytheon Technologies is proud to contribute to this sector as the world's largest aerospace and defense company and the second-largest commercial aerospace company, with a presence on nearly every commercial and defense aircraft. Essentially, we make everything for the aircraft except for the tube and wing. The part of Raytheon that I work in, Collins, is a 60 percent commercial business, and we provide many of the technologies that pilots use to power up the aircraft, fly across the country and around the world and bring those flights to a safe stop on the runway. From power generation to avionics, cabin interiors, landing systems and propellers, the list goes on.

This hearing topic is of particular importance to me and my colleagues because R&D is at the heart of what we do every day across our business, and I'm proud to say our spending reflects our values. In 2022, Raytheon Technologies invested more than $2.7 billion in internal R&D programs to develop technologies for our commercial, civil and defense market customers. We also operate the Raytheon Technologies Research Center with offices in Connecticut and California, which has been operating for 90 years and employs nearly 100 PhDs who are not assigned to a profit and loss center but instead partner with businesses to help develop low Technology Readiness Level (TRL) capabilities either in-house or in partnership with universities and federal research agencies.

While the innovation for these technologies largely occurs in the private sector, the government also plays an important role through its investments and partnerships. NASA's Aeronautics Mission Directorate, the FAA's R&D programs and other federal research agencies such as ARPA-E and DARPA play an important role in facilitating low to mid-TRL concepts that leverage private sector R&D to accelerate cutting-edge or uncertain technologies that can provide generational, rather than incremental, advances in aeronautics and where there is too much risk

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[1] https://www.trade.gov/leading-economic-indicators-aerospace-industry#:~:text=Indicators%20Aerospace%20Industry-,Overview,billion)%20among%20all%20manufacturing%20industries.

or too little incentive for the market to do so. Through relatively small dollar funding opportunities, risk-sharing and technology maturation, the federal government, industry and academic partners can collaborate to rapidly accelerate research, development and testing, leveraging the unique capabilities and resources of each partner.

Collins Aerospace, as a part of Raytheon Technologies, is focused on the technologies that will enable the launch of the next business, regional and commercial aircraft. Several major trends are defining the timing, architecture and competitive environment for industry that we urge the committee to keep in mind as it considers the upcoming FAA Reauthorization and R&D programs.

Global Aerospace Market at a Unique Turning Point

The aerospace industry is at a unique point in its history where, for the first time, there are very few new aircraft platforms currently in development or being certified. By contrast, for the past several decades, there were a great deal of new commercial and military platforms developed and certified globally.

While not all of these new aircraft are manufactured by U.S. companies, many of the systems and components that support them are designed and manufactured domestically. And there was much momentum in the expertise, knowledge and talent developed because of these programs. With their completion, there has been a sharp decline in commercial development as well as a re-focusing of military investment into recapitalization programs, evolving and updating existing platforms.

As we talk with our various aircraft manufacturer customers, it is clear that the timing of the launch of a new future aircraft will depend on the industry's ability to deliver a net improvement of at least 10-20% in efficiency from aircraft and propulsion technologies, along with other enhancements that improve the operator and passenger experience. These improvements in efficiency can only be reached through a combination of:

1. Continuous engine technology advancements
2. Lighter-weight and energy-efficient structures and systems on the aircraft
3. Route and operations optimization using connected aviation systems, and
4. Hybrid-electric propulsion technologies with electric motors, battery systems and controls.

I'm proud to say my colleagues at Raytheon Technologies, especially at Collins and Pratt & Whitney, are leading technology development in all of these areas identified as critical to the success of future aircraft safety, efficiency and performance goals. Our R&D investments and strategic technology areas are aligned around these key capabilities that will be critical to the launch of the next generation of clean-sheet aircraft and to meet the efficiency and safety goals necessary for such a program to be successful.

Current projections believe the next-generation business jet will likely be the next commercial program later this decade, followed by the next-generation single-aisle aircraft sometime in the mid-2030s. Many airframers will go a decade or more without developing and certifying a new aircraft, which is a significantly longer gap than we have seen in recent decades.

Current and Next Phase Needs of Aerospace

Based on the context provided above and other global factors, there are several discrete and unique challenges facing the aerospace industry today. These will be summarized briefly here and then addressed in further detail in the following testimony:

1. Technology maturation
2. Sustainability
3. Increased focus on safety
4. U.S. competitiveness
5. Workforce development

Technology Maturation

The next round of aircraft will feature a step-change in the technology incorporated into their designs. There are many examples of this from engines to structures, but I'll share one case study around our Rockford site's work and expertise: electric systems.

With a few exceptions, many of the new aircraft certified earlier this century have been iterations of existing technology, such as the use of constant frequency AC electrical power. Many aircraft use 115V AC power, similar to what we use in our homes, but at a higher frequency of 400 Hz to optimize power density and weight. Due to increased power demands anticipated for future aircraft, the next aircraft certified are expected to use high voltage DC power at levels of 540V or higher. Certain applications are exploring voltage levels of 800V and above. Future aircraft are expected to generate and consume higher levels of electrical power, and by utilizing higher voltages, lower weight and higher efficiency can be attained. These higher voltages will require new technology in power generation, distribution, switching, protection and control. Another example would be further integration of existing systems to reduce the number of potentially redundant electrical boxes or mechanical components on the aircraft to decrease weight, save cabin space, increase efficiency, and reduce cost. These are just two examples, but given the long period between platform developments, we expect to see similar examples of technology step-changes across the airframe and systems that support it.

With the desire to create such step-changes in technology, and because these next aircraft are not imminent, airframers are expecting full demonstration of these new technologies prior to the launch of new aircraft. This is a change from the past, when much of the technology was matured during the course of the aircraft development, and technology demonstrations will now be the norm for the next decade to increase confidence in maturity and success of the programs and help support aircraft safety. This means that industry needs to make advanced investments in technology maturation at a time when our commercial aviation industry is still recovering and returning to pre-pandemic levels.

Our approach to this can be multi-faceted.

1. Government, airframers and system suppliers can utilize the limited new build and recapitalization military platforms to help advance technology. For example, the Army's Future Long Range Assault Aircraft (FLRAA) program will be one of the first to utilize 540VDC electrical power generation. Although a positive, these opportunities will be limited in scope and the number of companies participating. Military recapitalization programs may also provide opportunities but they are largely an application of existing technologies designed to bring aging platforms up to current standards and capabilities.

2. Investment by private industry will need to continue, despite financial constraints. Individual companies are challenged by the fact that we have yet to return to 2019 levels of commercial air traffic and new aircraft production, and the industry's workforce and supply chains remain challenged during this recovery period. However, in order to remain viable and relevant, companies will need to find ways to continue investing in their unique technologies.

3. Government-funded programs will be critical to ensure continued progress. Programs such as the FAA's CLEEN and ASCENT R&D programs, Clean Aviation in the EU and NASA's Hybrid Thermally Efficiency Core (HyTEC) and Electrified Powertrain Flight Demonstrator (EPFD) programs are facilitating a great deal of technology development across the industry. The recently announced NASA Sustainable Flight Demonstrator with its new Transonic Truss Brace Wing (TTBW) structure and related technologies also is an important opportunity in partnership with industry. As you know, these programs are public-private partnerships, with some level of matching funding required from the companies participating.

It is important to note that the topic of technology advancement is not limited to design but applies to other critical aspects of the industry such as manufacturing and the environment. What we design is the direct need and focus of the approaches cited above, but how and where we manufacture the resulting design and what long-term impact it has on the environment are also areas of technology that require active development now.

To proactively address the potential question of U.S. companies waiting for government funding or being reluctant to self-invest, I wanted to provide some examples of what Collins is doing. Representing our Rockford site, I want to mention three major investments we are making in electric systems and hybrid-electric flight that are key to our competitiveness:

1. The first is a wind tunnel used for the production testing of our emergency power Ram Air Turbines (RATs), which are a critical safety system for aircraft that provide emergency power to help land an aircraft, should the need arise. In fact, our Ram Air Turbines have helped save more than 2,400 lives to date. Collins invested $18 million to build a highly-specialized wind tunnel focused on safety, quality, and efficiency. As wind tunnels are designed to support the product they test and our product is specialized, this has resulted in a completely unique testing facility that exists nowhere else.

2. Later this year, we will be opening a brand-new facility in Rockford called "The Grid," the next generation electric power systems laboratory that will be used to develop high-power, high efficiency motors, motor controllers, generators and distribution systems, in addition to system integration. This $50 million investment by Collins to build The Grid demonstrates our commitment to these technologies and our commitment to the Rockford footprint. This 25,000 square foot facility will have four modular labs that interconnect to allow engineers to develop components both independently and as an interconnected system. Dual control rooms will support two programs running simultaneously. The Grid builds on our long history of electric power systems labs, including our Boeing 787 lab for complete certification of our system prior to delivery and a similar lab for our Airbus A220

systems. In addition to testing and developing our own programs inside Raytheon Technologies, The Grid could also be used for academia and government programs.

3. Lastly, Collins is several years into the development of state-of-the-art high-voltage DC motors that will enable hybrid-electric propulsion and the further electrification of future platforms. In December 2022, Pratt & Whitney Canada successfully completed the first engine run of the regional hybrid-electric flight demonstrator, which is targeting a 30% improvement in fuel efficiency and CO_2 emissions compared to today's most advanced regional turboprop aircraft. The hybrid-electric propulsion system fully integrates a Collins Aerospace 1 megawatt (MW) electric motor with a highly efficient Pratt & Whitney fuel-burning engine and is expected to begin flight testing in 2024. The Grid will be utilized to test the 1 MW motor, motor drives and supporting systems such as batteries, distribution and protection as we scale this particular motor system up to 2 MW or down to lower power ratings, based on the application. These latest systems build on our long history of aircraft power generation, with decades of experience supporting key electric aircraft programs like the Boeing 787 and Lockheed Martin F-35 Lightning II.

Sustainability

There is a significant focus on sustainability driven by U.S. and international regulations, intergovernmental agreements, and market pressures. In order to be successful, any new platforms must be competitive and compliant not only with regulations and market demands in the U.S., but also in Europe, Asia and other major markets that will shape key decisions around efficiency and performance.

The aerospace industry is focused on all aspects of sustainability from the environmental footprint of manufacturing to the operation of aircraft. Of particular interest and need for investment are technologies focused on aircraft propulsion. Three primary examples are the use of Sustainable Aviation Fuel (SAF), hybrid-electric propulsion, and the use of hydrogen to fuel engines or power fuel cells to generate electricity. Each of these three areas has its own unique challenges to become viable in a production and operational environment, and each require significant investment to do so. Raytheon Technologies, primarily through Collins and Pratt & Whitney, is investing heavily in these areas and partnering with other companies and governments around the world to supplement investments and accelerate advancement to maximize environmental benefit while helping customers meet their efficiency goals to make their next aircraft competitive and safe.

Evolving R&D Digital Practices Support Safety

Today in Aerospace & Defense (A&D), Digital twins are used in almost all phases of the product lifecycle including concept development, design, production, and in-service operation. Functional models are used for rapid prototyping in the concept development phase. Computer Aided Design (CAD) models are used in development to validate physical interfaces and assemblies. The CAD models are annotated with design data to support the manufacture and support of products. This advancement in aircraft and systems design also has opportunities for how the FAA and other federal agencies support R&D as well as testing and certification.

Over the last two decades, simulation has substantially reduced dependance on physical testing during design. Simulations are used in combination with tests for certification and to ensure the function and safety of designs. Digital twins are developed for production processes for planning and to validate the producibility of designs. Digital product data is used to automate inspection tasks and improve production quality. In service, models are combined with operational data to predict the useful life of components and to recommend maintenance actions. Today, however, these digital twins are developed for a single purpose in the lifecycle and often used in isolation. The connection between these models and the insights they enable with system specifications is manual and maintained within organizational boundaries.

With the expanded deployment of networks, computing, and embedded systems in A&D, Model Based Systems Engineering (MBSE) has emerged as an essential tool for managing complexity in the design of integrated systems. MBSE is used to formally document system functions, the expected operation, and how these functions are assigned to the parts of a complex system. Design specifications based on formalized modeling languages are replacing paper documents, allowing multiple organizations involved in delivering complex A&D systems to work with consistent representations of the overall system. This reduces the risk of inconsistencies in design data and ambiguity of interpretation for complex operational requirements.

Looking forward to the next generation of platforms in A&D, we can expect digital twins at each phase in the lifecycle and MBSE representations of architecture and specifications to be connected together in new ways to accelerate development, substantially reduce development risk, enable new innovations, and continue to enhance product safety. With migration of computing to the cloud and the emergence of open modeling standards, it is becoming more cost effective to connect digital twins across the product life cycle. Tools that support traceability (i.e. Graph databases) and workflow automation (i.e. DevOps pipelines) are also seeing expanded use as development migrates to the cloud. Rapid access to information across organizational boundaries and across phases of the lifecycle can be expected to drive speed and innovation. In addition, connecting digital twins and MBSE specifications in digital workflows will provide near real-time traceability from top-level functional requirements for an integrated system down to the lowest level software or hardware component. This can be used to link functional safety hazards from MBSE specifications with information from digital twins that emerges during design, testing, and in service to improve product safety and potentially streamline certification.

These applications and their benefits can be expected to emerge incrementally as connectivity among existing modeling practices is implemented by A&D companies on programs. Continued advancement of open modeling standards and their broad support within A&D and the ecosystem of supporting software vendors is critical to ensuring interoperability and connectivity within the A&D supply chain. This interoperability will be critical to capturing value from digital twins and MBSE during development of next-generation platforms.

U.S Competitiveness

As we look at the global competitive landscape, we see several major trends and challenges to longstanding U.S. leadership in aviation:

1. We are seeing orders of magnitude higher levels of spending by Europe, China and other countries in aeronautics R&D to help advance next-generation technologies. The U.S. on average has invested approximately $200 million annually for public-private partnerships on aeronautics R&D between NASA and the FAA, while we see at least 10 times that level of annual investment in Europe and China.

Europe is heavily investing in advancements of sustainability technologies. There is financial support available from the EU and many individual countries within it. The investments they are making can benefit U.S. industry as well, but many times the investment is based on the expectation that non-EU companies increase their local footprint, share resulting technology or have future plans for localizing manufacturing. So while we may all benefit globally and U.S. companies cannot ignore the benefit of outside investment, the U.S. could be left with a long-term disadvantage of these investments.

2. Expiration last year of the R&D tax credit which allowed for full expensing of R&D investments has made the United States one of only two developed countries (the other being Belgium) to have such a policy that diminishes incentives for R&D investment and that will impact technology development. At the same time, China has doubled its incentives for R&D investment. A manufacturer making R&D investments in China gets a $200 expense deduction for every $100 invested. In the U.S., that manufacturer gets only $10. The level of impact this tax change will have depends on many factors such as a company's financial portfolio, investment needs and ability to offset internal investment. Regardless, without the restoration of the R&D tax credit, the current policy will likely have a negative impact on the future competitiveness of domestic technology.

3. International agreements, foreign laws and regulations, and market pressure are driving manufacturers toward ambitious goals around emissions and noise reduction for the launch of any new aircraft, which risks our leadership if others are able to develop an aircraft and systems that enable them to come to market first with a more efficient aircraft. With timelines for the launch of a new aircraft uncertain, it creates a challenge for industry to align investments, technology roadmaps and workforce.

Continued leadership in aviation requires both industry and the government to focus their policies, investments and R&D programs to ensure that we continue to encourage private sector investments in cutting-edge technologies and to mature them at a rate that demonstrates viability so that industry can further refine, mature and scale to be competitive on future platforms. This committee has an important role to play in authorizing funding levels, focusing the FAA R&D programs on key areas of advanced technology, and I hope the committee will also champion restoration of the R&D tax credit with your colleagues on Ways & Means to ensure we are maximizing private sector investment as we consider further federal investments.

Workforce Issues

The U.S. aerospace workforce and its relative level of experience and expertise has been negatively impacted by the current lack of new aircraft development and certification, an aging workforce that has already seen high levels of retirement and is scheduled for more, and a challenging financial situation that has resulted in workforce reductions. In many cases, the talent lost due to the pandemic-driven downturn in 2020 has proven difficult to restore. In addition, the type of talent required will continue to evolve as processes become more digital and manufacturing processes become more automated.

Engineering and related technology roles are a particular area of concern. Aircraft, system and component design and certification expertise were in high demand in the first two decades of the century, but due to the trends previously cited, that demand has declined. As a result, many companies have seen the retirement of their most experienced talent and the remaining talent has not had the benefit of new programs to rebuild the collective skills of those who have left. In addition, the competition for talent has significantly increased, further contributing to this challenge.

The workforce challenge spans beyond engineering into other disciplines, primarily manufacturing. For example, while the Rockford region is the sixth-largest center of aerospace employment in the U.S.,[2] local manufacturers of all sizes are experiencing shortages of skilled and unskilled labor. The most immediate need is for employees with manufacturing and technical skills; machining, metalworking, and CNC operators are the trades in highest demand. Several companies indicate their inability to find skilled CNC operators has limited their sales potential. This is a significant matter as small manufacturers often do not have the capital to automate to address this issue. This challenge is not limited to Rockford. This is a consistent trend across Collins sites and one that our colleagues experience across the U.S. industry. Many aerospace suppliers cite critical talent shortages as their pacing issue to rebuild capacity to support the desired production ramp ups being pursued by the industry's largest airframers.

There are several opportunities to mitigate the effects discussed above. While not a complete solution, progress can be made.

1. Technology maturation and demonstration programs will help increase experience in industry. While these do not directly transition into certification and production, where much of the critical knowledge lies, they will increase our overall technical competence and allow us to rebuild specific skills and experience.
2. Military recapitalization programs provide a good opportunity for system and component suppliers to build skills in their organizations. While they may not drive new technologies, programs like the B-52 CERP, E-7A and SAOC will help many companies develop disciplines within engineering as well as drive demand for the supporting functions who run these programs.
3. Apprenticeships and internships are a time-tested method to pass along industry knowledge and are increasingly critical as the current manufacturing workforce ages and retires. Co-op programs are also a successful way to introduce students to industry and provide alternative learning for those students who may not aspire to obtain a four-year college degree. Companies like Raytheon Technologies and Collins are continuing to support their intern and co-op programs to provide a valuable avenue to build the next generation of talent.
4. Continued investment is needed to attract the workforce of tomorrow to STEM-related careers. This goes beyond education curriculum and requires companies like Collins to partner with local communities to introduce students to exciting and rewarding futures in STEM-related careers. In Rockford, Collins engages local schools and partners with the Discovery Center, a local children's museum and learning center, to sponsor educational programs and a mobile STEM lab to bring learning to students.

These examples do not replace the experience attained by the consistent certification of new platforms. Further collaboration will be required between U.S. companies and the government to

[2] https://rockfordil.com/about-raedc/raan/

bridge existing gaps. Whereas in the past, the industry could rely on the regular launch of new clean sheet aircraft to drive technologies and R&D timelines, there will now be a multi-decade gap between the most recent new aircraft and the planned next-generation new single-aisle and wide-body aircraft. Reflecting on that gap brings perspective to the talent continuity from the last aircraft to the next.

Key Recommendations for R&D and Technologies

Despite these trends and challenges, I remain optimistic about the technologies that the U.S. and its industry are developing to enable innovative and competitive aircraft for the 2030s and beyond. Raytheon Technologies and Collins have made major strategic investments in key areas, including: hybrid-electric systems, advanced structures using thermoplastics and additive manufacturing, and connected aviation systems that are leveraging best-in-class software solutions for flight profile optimization, connected aircraft data and other predictive analytics to make more efficient decisions surrounding flight management and aircraft maintenance. Additionally, our colleagues at Pratt & Whitney are continuing to build on the success of the Geared Turbofan (GTF) engine over the last decade around additional innovations that will increase efficiency, lower carbon emissions and lower overall operating costs for operators. Only by combining engine technology improvements, electrification technologies, weight-reducing advanced structures, and connected software and data capabilities with the wider availability and adoption of sustainable aviation fuels will we preserve competitiveness in the global marketplace and meet government and industry goals for efficiency and sustainability.

Past and present R&D investments by the government and industry have led to the testing and maturing of technologies that are now broadly adopted across the industry on aircraft and have resulted in significant reductions in emissions and noise. Together with our sister Raytheon Technologies businesses, Collins has worked with federal agencies, including FAA R&D, in developing, testing, and bringing to market cleaner fuels, electrification, advanced materials to achieve meaningful weight reductions, and optimized airspace integration and aircraft operations that collectively represent a comprehensive approach to greater efficiency.

The FAA's R&D programs, especially the CLEEN, FAST, and ASCENT programs, have been instrumental in advancing key technologies for aircraft and engine manufacturers and suppliers. These programs have led to improvements in advanced materials that reduce aircraft weight, propulsion systems that reduce noise and emissions, and cleaner fuels that are critical to meeting global emissions reduction standards. Additionally, the FAA's work with the Department of Energy to research, develop, test, and certify cleaner fuels—such as new SAF feedstocks, hydrogen, and advanced batteries capable of supporting electric propulsion—are critical.

Recommendations for R&D programs in the FAA Reauthorization Act of 2023:

1. **Increase authorized funding for FAA R&D to ensure continued U.S. competitiveness.** We encourage that the committee reauthorize and consider the relevant funding levels needed for FAA R&D programs, including CLEEN, to ensure continued competitiveness and the health of the aviation sector. We also encourage the committee to build on existing programs that facilitate regional hubs for clean fuels and encourage partnerships with universities to advance R&D while building the STEM

workforce pipeline. The bill should also encourage and fully support FAA collaboration with the Department of Energy to accelerate R&D investment and certification of clean fuels, such as additional SAF feedstocks, hydrogen, ammonia, and advanced battery storage for electric propulsion.

2. **Align FAA R&D and other federal research programs around the key technology areas necessary to demonstrate efficiency, sustainability and competitiveness goals including:**

    a. Programs focused on aircraft electrification, fuel cell and battery storage, and hybrid-electric flight technologies
    b. Programs focused on sustainable aviation structures to support R&D and technologies to reduce weight, improve safety, and advance sustainability on the aircraft
    c. Programs to fully leverage advanced data sciences and connected aviation software capabilities to rapidly develop, test, and pilot software-based technologies.

3. **Expand on the Fueling Aviation's Sustainable Transition (FAST) program.** Expand success of the FAA FAST program to accelerate development and demonstration of electrification and other low-emission aviation technologies.

4. **Improve coordination with NASA on technology roadmap, funding, and flight testing, including opportunities to test FAA R&D technologies on the NASA Sustainable Flight Demonstrator.** Coordinate with NASA Aeronautics on utilization of the Transonic Truss Brace Wing Sustainable Flight Demonstrator X-plane as a test platform to conduct flight testing of technologies developed by FAA R&D, including those partnerships with industry through the CLEEN program.

Conclusion

In conclusion, I want to thank Chairman Babin, Ranking Member Sorensen and all the members of this committee for the opportunity to appear before you today and share industry perspectives on R&D opportunities in your upcoming authorization bill. The oversight and authorization work you do is critical to ensuring our continued competitiveness in global aviation for the decades ahead. Policies and programs that support continued R&D investments at the federal and industry level and encourage successful public-private partnership opportunities will be key to meeting this moment.

I want to invite you to visit our Rockford site to see the innovative work our employees do around electric power and hybrid-electric systems, and to join us for the opening of our new lab, "The Grid," later this year. You will be impressed with the dedication and enthusiasm throughout the U.S. aviation workforce for the technologies we are working on to enable the next chapter of safe and more efficient flight. Thank you.

Eric Cunningham – Vice President – Electric Power Systems, Collins Aerospace

Eric Cunningham is the Vice President for Collins Aerospace Electric Power Systems (EPS), based in Rockford, IL. Eric began his career as a Sundstrand Generator Engineer in 1999, working design, development, and production programs. From there, he has held roles of increasing responsibility in engineering, Engine Control Systems and EPS Program Management for military and commercial programs, quality, and operations. Eric has spent the past several years in customer-facing roles leading the EPS International, Business and Regional Jet Value Stream and, most recently, the EPS Military Value Stream.

Eric grew up in Winnebago County, IL, and has always had a passion for hands-on understanding of how things work and how to improve them. From his days growing up on the family farm, to a high school job in a machine shop, to an internship with the local electric utility provider, he has grown and honed this skill. And Eric has continued to apply this passion during his career with multiple experiences in program product development, including: Hawker Horizon – first commercial variable frequency generation system, 787 generator design and development, 787 Entry Into Service (EIS) maturation, Embraer KC-390 electrical power generation system, and G7500 electrical power system certification. Eric has also been a part of ongoing development and support of multiple military platforms such as the F-22, F-35, AEW&C, and P-8 as well as securing new product development to support platforms such as B-52, and E-7A.

Eric earned his bachelor's degree in Electrical and Computer Engineering from the University of Illinois, specializing in Power and Energy Systems, and his Masters of Business Administration from Rockford College.