DRONE INTEGRATION FUNDING

Report of the Drone Advisory Committee

Interim Report – June 2017
Funding the Integration of UAS into the National Airspace

1. Executive Summary

The Drone Advisory Subcommittee established Task Group 3 (TG3) to look at issues related to funding the integration of UAS into the National Airspace System (NAS). This interim report primarily makes recommendations about funding sources for the next 24 months (defined as “near term”), considers what activities should be prioritized, and who should be responsible for funding UAS integration activities (Appendix 1). TG3 came to consensus on the following points:

- All regulations, policies, and standards necessary in the next 24 months should be developed primarily by the Federal Aviation Administration (FAA), with significant industry input. We recommend that Congress appropriate additional funding and increase FAA staffing to address this ambitious work schedule.
- The research and development, and system development necessary in the next 24 months, should be shared between government and industry.
- Communications, outreach, and training necessary in the next 24 months should be shared between government and industry, depending on the activity.
- Any recommended funding structure should not alter the current structure of funding for traditional, manned aviation.
- In the future, the UAS industry may be expected to pay for the operation, maintenance, and modernization of an automated Unmanned Traffic Management (UTM) system through a yet-to-be-created “pay-for-what-you-use” funding model.

2. Background

In March 2017, the FAA formally asked the DAC to recommend how best to fund the full complement of activities and services required both by government and industry to safely integrate UAS operations into the NAS in the short and longer term. TG3 was assigned this task. TG3 has 51 participants, including 20 observers from the FAA. See Appendix 3 for a complete list of voting members and observers. Participants are from a cross-section of stakeholder groups from unmanned and manned aircraft manufacture, application, and operations.

The FAA Tasking Statement (see Appendix 2) posed a series of related questions:
• Who should be responsible for conducting the identified activities and services needed to support the safe integration of UAS operations into the NAS?
  o Are there activities and services that could be performed by industry in the near-term or longer-term, or through a public/private partnership?
• For the activities the FAA should perform, what level of funding resources are needed to support the safe integration of UAS operations into the NAS?
  o If funding is insufficient, which activities or services have the highest priority?
• What funding mechanisms should be used to support these activities and services?
  o What activities and services should the Federal Government perform using traditional funding methods (such as taxes or fees)?
  o Should different Federal activities or services be paid for differently?
  o Should different types of UAS pay different amounts or via different mechanisms?
• How should the funding mechanisms be implemented for the near-term, and how might they change as the industry evolves?
  o Is there a recommended phased or incremental approach?
  o What are the implementation issues and costs?
  o What incentives or unintended consequences might result?
• What options were explored and rejected?

3. **Scope**

The FAA asked TG3 to provide near term recommendations by July 2017, and longer term recommendations by March 2018. The recommendations in this report are interim recommendations for funding over the next 24 months.

4. **Assumptions and Guiding Principles**

Task Group 3 had three primary assumptions and guiding principles:

• There will be a combination of government, industry, and shared funding across the integration efforts.
• Options for funding should not be constrained by the current traditional aviation funding structure.
• The recommended funding structure should not alter the current structure of funding for traditional, manned aviation.

5. **Methodology**

The following summarizes the approach and methodology TG3 used to develop this interim report.
First, the FAA gave the group briefings on the budget, public private partnerships, the UAS Implementation Plan, aviation taxes, and the 2017 appropriations. The group also reviewed a historical perspective of the air traffic control system and the establishment of the Aviation Trust Fund (Appendices 4 and 5). This look-back helped the group understand what it took to foster the vibrant and flourishing manned air commerce industry of today. Following these briefings, the group discussed the process options with an aim towards collaboration, consensus, and transparency. The group then agreed to use the Analytical Hierarchy Process (AHP) developed by Decision Lens (DL) to prioritize the activities and recommendations. AHP is a decision-making process that abstracts criteria and weights and allows the user to focus on attributes that they recognize. The user compares and rates the importance of criteria and then evaluates options based on those criteria. The AHP is capable of bringing together numerous stakeholders who may have multiple and competing objectives to reach decisions and prioritize alternatives.

The efforts that support the safe and efficient integration of UAS into the NAS are spread across many offices and programs in the FAA. The FAA provided TG3 with the activities to be evaluated for funding, see Appendix 5. The group ranked each FAA activity against the following criteria:

- Safety among UAS operators, for people and property on the ground, and with current manned aviation, given a 60% weight.
- Enabling operations and technological readiness, given a 28% weight.
- Economic benefits to society and the government, given a 12% weight.

The vast majority of the members participated in the rating and ranking process. The result of this was a prioritized list of FAA activities, in rank order. The group then validated the results and discussed the need to address like activities together and to prioritize foundational activities. The group divided into three teams and provided written recommendations for priorities and funding for their assigned issues. The reports were circulated and discussed, and consensus was reached on the recommendations. The reports were then consolidated and this final report was circulated for review and approval.

6. Prioritized List of Activities and Initiatives That Need Funding or Resources

The value differential between the top of the list and the bottom was small; accordingly, it is clear that the activities are all deemed important. The top five priorities were:

- Pilot Certifications/Qualifications Standards
- Air Traffic Management R&D
- Flight Standards Policies and Procedures
- Injury Severity R&D
- Rulemaking
The group also discussed which activities, although not in the top 5, were foundational to successful UAS integration. Those additional activities were:

- Air Traffic Control
- Traffic Management System
- Registration System

The full results of the DL ranking are below and at Appendix 6.


In order to safely and efficiently integrate UAS into the NAS, consistent with the FAA Implementation Plan, there are many activities that must take place and be funded, both by the government and by industry. Consistent with current FAA implementation plans, TG3 recommends funding over the next 24 months for critical: Regulations, Policies, and Standards; R&D and Systems; and Outreach and Training. Each is discussed below, and summarized at Appendix 7.

Regulations, Policies, and Standards
Rulemaking activities considered are those necessary to enable UAS milestones and any necessary to implement public law changes. Policies and procedures are guidance documents that must be developed to enable UAS milestones for air traffic control, air traffic management, UAS operators, manufacturers, and other airspace users. Standards are those needed to guide the technical and operational aspects of the operational milestone.

TG3 identified seven priority rulemakings for the next 24 months. Each would progress at least to the notice of proposed rulemaking stage by the end of this period. These regulations will be developed primarily by the FAA, with significant industry input. It may not be possible for the FAA to undertake all of these activities over this short period of time with existing personnel and resources. Thus, we recommend that Congress appropriate additional funding and increase FAA staffing to address this ambitious work schedule. Industry will continue to participate in pre-rulemaking activities, comment on proposed rules, and participate in standards development. FAA will continue its traditional government role in rulemaking, guidance, enforcement, and informal adjudications. The rulemakings in italics are not included in the FAA’s current rulemaking plan.

- Operations Over People (OOP)
- Identification and Tracking
- Section 2209 – Designation of prohibited or restricted airspace above certain fixed-site facilities
- Counter-drone Operations and Activities
- Expanded Operations (BVLOS, package delivery)
- Air Carrier Certification and Operations
- UAS Fee Structure

Whether FAA can achieve these rulemaking milestones within the 24-month period depends on a number of factors, including: the Administration’s timely approval of the FAA’s rulemaking plan; the impact of the so-called two-for-one Executive Order; and effective collaboration between FAA and the national security and law enforcement agencies on security issues, including provisions of the 2016 FAA extension. We recognize these factors threaten to delay the regulatory timeline beyond the 24-month period. However, TG3 encourages the FAA to move forward with the UAS rulemaking process as expeditiously as possible and up to the limits of the Executive Order.

We list the OOP Rulemaking first because the proposed rule is likely a finished product.

We list an Identification and Tracking Rulemaking. While the ARC will recommend standards, if compliance is to be mandatory, a rulemaking will be required. So, too, if UAS operators not equipped to be remotely identified and tracked will be prohibited to fly in particular airspace, a rulemaking is necessary. We list this rulemaking separately from the security rulemaking because identification and tracking will address safety, privacy, and security concerns.
We believe the FAA will embark on a **Section 2209 Rulemaking**, addressing airspace above certain fixed-site facilities, although rulemaking is not required by section 2209.

The **Security Rulemaking** will address counter-drone operations and activities. It is uncertain whether this rulemaking activity would be conducted by FAA, DOJ, DHS, or be a joint rulemaking effort. Conceivably, a single security rulemaking package could cover section 2209 and counter-drone operations.

The **Expanded Operations Rulemaking**, addressing BVLOS and package delivery, may be delayed until the FAA has published proposed, if not final, rules addressing identification and tracking, fixed-site facilities, and counter-drone activities.

The **Air Carrier Certification and Operations Rulemaking**, establishing an UAS air carrier certification process and operational rules, could be included as part of the expanded operations rulemaking.

Finally, we envision an **UAS Fee Structure Rulemaking**, under which the FAA would establish fees to be charged for certain work performed by the FAA. Before such a fee structure could be established, Congress must authorize it. We have included this rulemaking as a placeholder as we believe a fee system should be considered for long-term sustainable funding for certain programs and activities. If such a fee structure is authorized by law, any rulemaking required to impose and collect such fees should be a high priority.

After the rulemakings are complete, FAA may promulgate Orders and Advisory Circulars, and may need to establish a waiver, exemption, certification, or other approval process. The responsibility will largely fall to FAA personnel to draft documents and to handle any approval process emanating from the rule. While the FAA has primary responsibility for these activities, it will be critical to have significant industry participation.

We have identified four areas where **Policies and Procedures** should be prioritized in the next two years:

- Flights Standards
- Air Traffic Control
- Operator
- Airports

The FAA typically publishes additional guidance once a rule is published. This guidance should include policies and procedures for **Flight Standards**, **Air Traffic Control**, and **Airports**. The responsibility for these three policies should rest with the FAA. We recommend that Congress appropriate additional funding and increase FAA staffing to address this ambitious work schedule if the FAA’s current resources cannot meet the need.
FAA may require Operator policies and procedures for specifications, capabilities and limitations, operations, and maintenance. UAS operators, especially businesses utilizing multiple UAS, should develop manuals and procedures for operators, quality assurance, remote pilots, and programmers. The responsibility for this category of activity is entirely with industry. If the FAA requires UAS manufacturers or operators to submit these manuals to the FAA for review and approval, however, this could add a substantial workload burden to the FAA.

We have identified four Standards that should be prioritized in the next two years, and we recommend that these be a collaborative effort between the FAA and industry:

- Pilot Certification and Qualification
- Airworthiness Certification
- Command and Control
- Detect and Avoid

Pilot Certification and Qualification Standards should be a collaborative effort between FAA and the manned and UAS pilot community. Pilot certification is required by statute, and the standards for issuance of a pilot certificate and ratings (other than a remote pilot certificate under Part 107) are set forth in Parts 61 and 65. Historically, Airman Certification Standards (ACS) have been developed in collaboration with the aviation industry. Part 107 requires passing an aeronautical knowledge test, but does not impose any training or experience requirements with respect to operating an UAS. As the regulatory landscape matures to permit operations at night, BVLOS, over people, and ultimately highly-automated operations, the FAA may seek to impose new risk-based training and experience requirements (or risk-based equivalency standards for automated systems).

We are unaware of any standards organizations currently examining UAS Airworthiness Certification Standards, but we expect this work will begin in earnest once the FAA rulemaking initiative for expanded operations begins. This could well come within the 24-month timeframe. Development of these standards would be a collaborative undertaking between the FAA and industry.

The subject of Command and Control (C2) Standards involves UAS equipage and spectrum issues. RTCA SC-228 last year published a Minimum Operations Performance Standard (MOPS) for terrestrial data link C2. A Phase 2 white paper addressing satellite-based C2 issues is expected to be published this summer. One of Task Group 2’s recommendations to the DAC—to evaluate the ability of existing cellular networks to meet low altitude UAS C2 requirements—states further that the “FAA should evaluate and validate the 3GPP work study items (Study on Enhanced Support for Aerial), and that the “FAA should establish an operational prototype that includes cellular connectivity, via the existing commercial cellular networks, as a C2 option . . .” This may suggest that industry’s work on C2 is complete, and the baton is passed to the FAA. However, we believe additional work on C2 is necessary, to look at other technologies and to look at use cases beyond the low altitude within the Mode C Veil framework in the next 24 months.
Regarding **Detect and Avoid (D&A) Standards**, RTCA SC-228 has completed a Minimum Operations Performance Standard (MOPS) recommending D&A capability for UAS operating IFR in controlled airspace. Phase 2 will address D&A equipment necessary to support UAS operations in Class D, E, and G airspace. Detect and avoid technology remains one of the main challenges to expanded UAS operations. Many companies are developing sensor-based technology to address this issue. We believe the development of D&A performance standards should be a high priority. The UAS industry should develop these standards in collaboration with the FAA and other stakeholders, SC 147 (Alert and Collision Avoidance), SEC 2202 ARC (Remote ID Standards), and the LAANC concept.

**Research and Development and Systems**

The FAA and industry each have a role to play in R&D and Systems development. The FAA should prioritize R&D and Systems funding based on the foundational-building blocks needed to create an automated system that can scale with the rapidly growing drone industry.

We have identified three near-term priorities that should be supported and funded by government and industry within the next 24 months:

- **LAANC**
  - Related R&D Activity: Air Traffic Management, C2 & Spectrum, Separation

- **IT Gateway**
  - Related R&D Activity: Air Traffic Management, Separation

- **UTM**
  - Related R&D Activity: Air Traffic Management, C2 & Spectrum, Separation, Human Factors, Environmental

Low Altitude Authorization and Notification Capability (**LAANC**) will automate the process for UAS operators to notify Air Traffic Control of flights within five miles of an airport center, or to get authorization to fly in certain classes of airspace. It is the first step toward implementing **UTM**, a system for enabling safe, efficient low-altitude operations.

The **IT Gateway** is a common web portal and associated software that will serve as a one-stop-shop for all UAS interactions with the FAA, allowing owners and operators to register their aircraft, apply for airspace authorization or waiver, file an accident report, and get the latest news.
The UAS Traffic Management (UTM) system will enable safe and efficient low-altitude operations by developing technologies such as airspace design, dynamic geofencing, congestion management, and terrain avoidance.

To stay at the forefront of this emerging global industry, the federal government (FAA, NASA, FCC, and others) should continue to make short-term R&D and systems investments to spur innovation and help create an automated IT infrastructure that will allow the industry to scale. To the extent that the FAA, the Administration, and Congress deem necessary, additional funds should be appropriated for these efforts.

Industry should also continue to invest in R&D and system development. Some areas where industry is leading include work on C2 and spectrum issues. The industry is currently working with the FAA on LAANC; and with the FAA and NASA on UTM development. Once UTM is implemented, industry may be expected to pay-for and manage the system.

Injury Severity R&D is primarily used to help inform FAA rulemaking. Moving forward we envision this being a collaborative effort, similar to what is being done at the UAS Center of Excellence.

The Task Group 2 recommendations below fall within the above activities:

- Prioritize sUAS BVLOS operations within the Mode C Veil below 400 ft AGL.
- Development of technology neutral navigation performance requirements
- Evaluate the minimum requirements needed to meet low altitude UAS C2 operations.
- Establish a FAR Part 135 regulatory “pathfinder” program (and draw upon findings and from other pathfinder programs) for commercial UAS low-altitude (<400’) BVLOS operations

These activities should be prioritized for funding and the FAA should enable any program and project planning necessary to trigger funding for these foundational activities.

Outreach, Communications, and Training

Effective outreach, communications, and training will be critical for the successful integration of UAS into the NAS and growth of the industry. Outreach and communications include efforts with the public, stakeholders, and Congress to address concerns raised by communities and interest groups. Training in this context generally means training of the FAA workforce, including Air Traffic Control Training, Flight Standards Training, Airports Training, and AVS/AOV Oversight Training. Near term funding for outreach, communication, and training should be shared by the FAA and industry.

Outreach and Communication efforts can continue using techniques that are currently being implemented by community-based organizations, local governments, the FAA, and other UAS
industry stakeholders. The most realistic approach is to share the accountability between publicly and privately funded organizations.

Outreach and communication should be a shared responsibility between the FAA and the industry. The current situation shows the burden weighing more on industry than on the FAA, and this trend may continue in the future. The FAA may need to increase support for these programs through various methods, including public support and enforcement of violations.

An example of this outreach/communication is the *Know before You Fly* campaign. *Know before You Fly* is an educational campaign that provides prospective users with the information and guidance they need to fly safely and responsibly. This campaign was founded by two organizations with a stake in UAS safety: the Association for Unmanned Vehicle Systems International (AUVSI) and the Academy of Model Aeronautics (AMA). It is conducted in partnership with the FAA, and has the official support of nearly 200 companies, including Walmart, Amazon, and Best Buy.

Other examples of outreach can be seen in UAS Public Service Announcements created and broadcasted by Sinclair Broadcasting Group, Best Buy employee training regarding UAS regulations, Walmart Know Before You Fly shelving displays, and Amazon’s Fly Responsibly website links. These examples highlight how communications and outreach can and should be shared between industry and the government.

With respect to Training, in the near-term, funding for training should be provided by a dedicated funding stream created by Congress. Formal training for FAA workforce, which includes Air Traffic Control, Flight Standards, Airports, and other oversight, can also be augmented with industry training options.

8. Approach to Longer-Term Funding

Beyond 24 months, TG3 will work with the DAC and the FAA to identify self-sustaining and scalable funding sources that allow all users of the NAS to fund the resources to ensure its safe and efficient operation. The industry, the FAA, and Congress should work together to identify a funding structure for the UAS industry that is segregated from the system that funds manned aviation. The funding mechanism should be flexible enough to support potential far-reaching structural changes to FAA funding and activities. TG3 will consider new sources of funding for the long term, including user fees or similar pay-for-what-you-use services.

9. Estimated Resources that will be Required for Activities and Initiatives

It is difficult to determine the exact financial resources the FAA will need to conduct all of the activities discussed herein. Congress has appropriated dedicated funds for UAS activities at the
FAA. Ideally, these funds would be appropriately segregated from funds that support manned aviation.

For the necessary **Rulemakings, Policies, and Standards** discussed herein, we do not know whether the FAA has calculated the number of staff used for the interim final rule on electronic registration, Part 107, or the not-yet-published OOP proposed rule. Such a calculation could be used to estimate the number of FTEs necessary to complete current and future rulemakings.

For **R&D and Systems**, TG3 does not have enough information on current FAA UAS funding to estimate future resource requirements. The FY17 enacted budget for Research, Engineering, and Development (RE&D) is $20 million, but drops to $7 million in the FY18 budget request. This decrease may not support the projected increase in the continued development of UTM.

For **Training**, the working group researched course fees for similar training programs to find that costs range from $650-$1,200 per course per student. Assuming an average of six operations personnel per Part 139 airport are trained for an average of $1,000 each, we conclude that these training initiatives can be achieved in the near-term for approximately $3 million. If one employee from each of the 1,000 general aviation airports also receive training, for a cost of $1 million, we estimate a total short-term funding requirement of $4 million.

10. **Time Frames**

The above activities should be prioritized in the next 24 months. This is an ambitious timetable that will require additional funds to be appropriated to ensure sufficient staffing and availability of FAA personnel to work on these activities, in a parallel manner.

11. **Potential Funding Mechanisms**

In the near-term, funding should be provided by additional appropriations from Congress, as an investment in a growing segment of the aviation industry, and, as discussed throughout, from **Industry**. All efforts should be made to fund these initiatives outside of the Aviation Trust Fund.

For the longer term, the DAC and FAA should work to identify methods for larger, runway dependent funding sources specifically for UAS. Options to consider include local user fees paid to airports, and small UAS could contribute to the safe and efficient operation of the NAS through other industry based-fees or charges. Once the regulations are issued and the enabling automated IT systems have been created, the UAS industry may be expected to pay for the operation, maintenance, and modernization of those systems through a yet-to-be-created “pay-for-what-you-use” funding model. It is too early to determine a definitive long-term funding structure.

Given the nascent industry, public private partnerships (PPP) should be encouraged. Currently, there are UAS R&D and system PPP at the FAA’s William J. Hughes Technical Center, the FAA’s
Center of Excellence, pathfinder programs, partnerships for safety, test sites, and with Federally Funded Research and Development Centers, such as MITRE.

12. Appendices

- Appendix 1 – FAA UAS Integration Activities
- Appendix 2 – List of TG3 voting members
- Appendix 3 – FAA Tasking Statement
- Appendix 4 – Celebrating 75 Years of Federal Air Traffic Control
- Appendix 5 – Genesis of Aviation Taxes
- Appendix 6 – Decision Lens Results
- Appendix 7 – Funding Recommendations for each FAA Activity
Appendix 1

Integration Breadth and Depth

Categories

Rulemaking
- NPRM
- Final
- Associated Rulemaking
  - C2 & Spectrum
  - Separation
  - Human Factors
  - Air Traffic Management

R&D
- Injury Severity
- Environmental

Standards
- Size/Impact Energy
- Airworthiness Certification
- Pilot/Certs/Quals
- C2 Standards
- DAA Standards
- Environmental

Policies/Procedures
- Operators
- Air Traffic Control
- Flight Standards
- AVS/AOV Oversight
- Authorization Portal

Airspace
- Charting
- Airports

Training
- Air Traffic Control
- Flight Standards
- Airports

Systems
- Registration System
- Traffic Mgt System
- CNS Systems
- ATC Systems/Capabilities
- Spectrum Management
- Other

Outreach/Communication
- Pilots/Operators
- General Public
- Manufacturers
- Internal FAA
Appendix 2

Mark Aitken
Erik Amend
Amanda Armistead
Justin Barkowski
Darby Becker
Marcus Boukedes
Chad Budreau
Peter Challan
Claudia Chaudhari
Ann Cihon
Diana Cooper
Bill Davis
Joe DePete
Brian Devine
Tyler Dobbs
John Eagerton
Nancy Ford
Ben Gielow
Sharon Glasgow
Matthew Grosack
Michelle Guynn
Chris Harm
Doug Johnson
Henry Jones
Howard Kass
Charlie Keegan
Lance King
Nick Lento

William "Chris" Lucius
Meghan Ludtke
Ben Marcus
Gregory McNeal
Ralph Morris
Margaret Nagle
Casey Nair
Chin Pann
Sharon Pinkerton
Laura Ponto
Dawn Ramirez
Mark Reed
Jon Resnick
Megan Rosia
Mike Rottinghaus
Bob Schramm
Al Secen
Nan Shellabarger
Joanne Snow
Suzanne Styc
Chloe Svolos
Justin Towles
Greg Walden
Jennifer Warren
Steve Weidner
Jay Wells
Greg White
Dan Williams
Drone Advisory Committee (DAC) – Task Group 3
Tasking on Unmanned Aircraft Systems (UAS) Funding
March 7, 2017

ACTION: Tasking on UAS funding.

SUMMARY: The Federal Aviation Administration (FAA) asks the DAC to provide recommendations for options on how to fund the activities and services required both by government and industry to safely integrate UAS operations into the National Airspace System (NAS) over the near and longer terms. The FAA would welcome consideration of a broad array of options, including industry assuming a lead role for certain aspects, or public-private partnerships between government and industry. This would include an evaluation of which activities and services are more efficiently done by the government, which could be performed effectively by industry, and considerations of short-term practicality and eventual scalability.

Most of the FAA’s funding comes from aviation users, through a series of excise taxes on airline passengers and shippers, fuel taxes, and user fees for registration, aeronautical charting, and overflights of U.S. airspace. As the UAS sector is growing, so are its demands on FAA staffing and other resources. What will be required to safely integrate UAS will be an ongoing conversation between government and industry, but it is important to note that this work will be added on to FAA’s already constrained budget. The FAA is committed to full integration of UAS into the NAS, which requires additional resources to support the required new and ongoing activities. The FAA has a draft plan describing the activities needed over the next two to five years to facilitate the integration of UAS into the NAS. Progress on integration is essential to maintain U.S. competitiveness in this field while also sustaining the exemplary aviation safety record.

TASK: The FAA tasks the DAC to evaluate and analyze potential mechanisms for UAS users to fund the activities and services required to safely integrate UAS operations into the NAS over the near term. The DAC is to make recommendations to the FAA reflecting a consensus view that could be used to inform near-term government action. In the event of failure to reach consensus, majority and minority reports may be submitted. FAA subject matter experts will be available to assist as needed.

Develop Recommendations

The Task Group should develop recommendations as to the UAS community’s preferred method(s) for funding Federal activities and services required to support UAS operations for the next two years, and beyond. Multiple options may be explored and analyzed. The report should address:
1. Who should be responsible for conducting the identified activities and services needed to support the safe integration of UAS operations into the NAS?
   • Are there activities and services that could be performed by industry in the near-term or longer-term, or through a public/private partnership?
2. For the activities the FAA should perform, what level of funding resources are needed to support the safe integration of UAS operations into the NAS?
   • If funding is insufficient, which activities or services have the highest priority?
3. What funding mechanisms should be used to support these activities and services?
   • What activities and services should the Federal Government perform using traditional funding methods (such as taxes or fees)?
   • Should different Federal activities or services be paid for differently?
   • Should different types of UAS pay different amounts or via different mechanisms?
4. How could the funding mechanisms be implemented for the near-term, and how might they change as the industry evolves?
   • Is there a recommended phased or incremental approach?
   • What are the implementation issues and costs?
   • What incentives or unintended consequences might result?
5. What options were explored and rejected? Why were they rejected?

SCHEDULE: The Task Group’s interim recommendation report should be submitted to the Drone Advisory Committee no later than June 30, 2017 to enable DAC consideration via teleconference in July. The Task Group should then consider feedback from the DAC, as well as the longer term evolution of funding, in a report by March 2018.

FOR FURTHER INFORMATION CONTACT: Victoria Wassmer, Acting Deputy Administrator and Chief NextGen Officer (ADA-1), and DAC Designated Federal Official (DFO) at (202) 267-8111; or Earl Lawrence, Director, Unmanned Aircraft Systems Integration Office (AUS-1) and DAC Sub Committee Federal Lead at (202) 267-0168.

Issued in Washington, DC, on March 7, 2017.

Victoria B. Wassmer
Deputy Administrator (A), Chief NextGen Officer
and DAC Designated Federal Official

BACKGROUND:

The FAA faces challenges of budget instability, budget inadequacies, and lack of management flexibility. In order to facilitate the introduction, integration and on-going operations of UAS throughout the United States, the FAA requires new resources to be devoted to this task. The UAS Implementation Plan lays out the myriad UAS activities of the Agency over the next few years and many of them require additional funds.
Up to this point, the FAA’s UAS efforts have been funded primarily by reallocating personnel and shifting internal funds to support these activities, which include standing up the UAS Integration Office, developing the Agency’s framework for UAS integration into the NAS, and conducting the initial implementation of the Small UAS Rule (14 CFR part 107). Absorbing these costs is impacting the FAA’s ability to meet its other responsibilities. While the FAA received funding for some UAS work in prior years, the requirements to meet UAS needs is outpacing the Agency’s resources. Without additional funds, the FAA will not be able to keep pace with the dramatic growth in public, industry, and business demands for UAS operations.

For example, after one month of implementing the Small UAS Rule, the demand for UAS operations had already overwhelmed our traditional systems and manual processes. The current processing and backlog of Waivers to Airspace Authorizations are similar to the issues with the exemption process for Section 333 of the FAA Modernization and Reform Act of 2012 (FMRA), which grants the Secretary of Transportation the authority to determine whether an airworthiness certificate is required for a UAS to operate safely in the NAS. However the backlog of waivers is worse due to an even higher public and industry demand. The FAA does not have the funding necessary to build automation systems that would allow the agency to meet public demand. Requirements from the recent reauthorization legislation (FAA Extension, Safety, and Security Act of 2016, P.L. 114-190) may also be impacted. For example, while the FAA will be able to conduct the pilot program on airspace hazard mitigation using unmanned aircraft detection systems required under Section 2206 of the reauthorization legislation (Public Law 114-190 (July 15, 2016)), the development and implementation may need third party investment, perhaps through a public-private partnership. This situation will grow more urgent as the FAA continues through the next phase of its rulemaking activities, such as enabling operations over people or beyond line of sight. And while significant UAS traffic management efforts may be borne by the private sector, integrating operations into the FAA’s air traffic control automation systems will require significant capital investment. Further, any services required to respond to the growth of UAS activities, whether counter-UAS, airspace management, or other types of service will most likely require additional investment and operational funding.

Looking beyond currently planned activities, if additional funding cannot be found, progress will be greatly impacted. All related activities required for FAA to fully integrate UAS operations into the NAS over the long-term – rulemaking, developing safety standards, conducting safety oversight, developing automation and other IT systems, and conducting research – will be impacted by limitations of FAA’s current funding. For example, in order to incorporate UAS into the NAS, current systems such as En Route Automation Modernization (ERAM) and Terminal Automation Modernization and Replacement (TAMR) might require significant modifications and this will require more funding.

**Industry Funded Models**

In terms of industry funded activities, the ARINC model provides a good example. ARINC, established in 1929 as Aeronautical Radio, Inc., is a major provider of transport communications and systems engineering solutions to commercial airlines and airports. It provides fee-based services to the aviation industry. It was chartered by the Federal Radio
Commission (which later became the Federal Communications Commission (FCC)) in order to serve as the airline industry’s single licensee and coordinator of radio communication outside of the government. Through most of its history, ARINC was owned by airlines and other aviation-related companies such as Boeing, until the sale to The Carlyle Group in October 2007, and then to Rockwell Collins in 2013.

ARINC took on the responsibility for all ground-based, aeronautical radio stations and for ensuring station compliance with FCC rules and regulations. ARINC expanded to support transport communications, as well as the commercial aviation industry and U.S. military. ARINC also helps develop consensus-based, voluntary technical standards for the aviation industry.

Other examples of industry-led activities include the FAA’s Designee program, where the FAA designates qualified technical people who are not FAA employees to perform certain exams, tests, and inspections necessary to comply with applicable standards. Industry conducts these activities using its own resources under FAA oversight.

The FAA does not charge U.S. manufacturers for aircraft certification; however, there are international models where authorities such as the European Aviation Safety Agency, (EASA) impose fees on applicants seeking EASA certificates of airworthiness.

**FAA Funding Today**

The FAA today is largely funded through a series of excise taxes imposed on aviation users. These revenues are collected in the Airport and Airway Trust Fund (Aviation Trust Fund). Congress appropriates funds for the FAA’s four budget accounts from two principal sources: the Aviation Trust Fund revenues, and contributions from the General Fund of the U.S. Treasury. Though the funds in the Aviation Trust Fund are generated by users of the airspace, they cannot be used by the FAA unless first authorized and appropriated by Congress.

The FAA has experienced a continuing resolution (CR) at the beginning of each fiscal year for the last 20 years, three instances of furloughs or shut downs in the last five years, and a series of authorization extensions (23 extensions of the last reauthorization, and currently on our third extension). Without certainty about funding levels each year, long term planning becomes extremely difficult. When operating under a CR, agencies must be careful not to overspend, so programs might not move forward as quickly as desired or expected. There is also a prohibition on “new starts” during a CR, limiting FAA’s ability to be quickly responsive to emerging issues.

**Airport and Airway Trust Fund (Aviation Trust Fund)**

Created in 1970, the Aviation Trust Fund constitutes the primary funding source for FAA programs. Each year since Fiscal Year (FY) 2012 the Aviation Trust Fund has provided no less than 71 percent of the FAA’s annual funding. In FY 2016, the Aviation Trust Fund constituted 87.8 percent of the FAA’s funding.
The Trust Fund receives revenues from a variety of excise taxes paid by users of the NAS. Aviation excise taxes are imposed on domestic passenger tickets, domestic flight segments, international passenger arrivals and departures, and on purchases of air travel miles for frequent flyer and similar programs. In addition, taxes are imposed on domestic air cargo waybills and aviation fuel purchases. These taxes fall into four broad categories: (1) domestic transportation of persons; (2) use of international air facilities; (3) domestic transportation of property (air cargo); and (4) domestic aviation fuel taxes.

### Aviation Trust Fund Excise Tax Structure

<table>
<thead>
<tr>
<th>Trust Fund Excise Tax Revenue Sources</th>
<th>Rates effective as of January 1, 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic passenger ticket tax</td>
<td>7.5 percent</td>
</tr>
<tr>
<td>Domestic flight segment tax</td>
<td>$4.10 per passenger per segment; indexed to the Consumer Price Index</td>
</tr>
<tr>
<td>(excluding flights to or from rural airports)</td>
<td></td>
</tr>
<tr>
<td>Tax on flights between the continental United States and Alaska or Hawaii (or between Alaska and Hawaii)</td>
<td>$9.00 per passenger; indexed to the Consumer Price Index</td>
</tr>
<tr>
<td>International arrival and departure tax</td>
<td>$18.00 per passenger; indexed to the Consumer Price Index</td>
</tr>
<tr>
<td>Tax on mileage awards (frequent flyer awards tax)</td>
<td>7.5 percent of value of miles</td>
</tr>
<tr>
<td>Domestic commercial fuel tax</td>
<td>4.3 cents per gallon</td>
</tr>
<tr>
<td>Domestic general aviation gasoline tax</td>
<td>19.3 cents per gallon</td>
</tr>
<tr>
<td>Domestic general aviation jet fuel tax</td>
<td>21.8 cents per gallon. Note: Effective after March 31, 2012 a 14.1 cents per gallon surcharge for fuel used in fractional ownership flights</td>
</tr>
<tr>
<td>Tax on domestic cargo or mail</td>
<td>6.25 percent on the price paid for transportation of domestic cargo or mail</td>
</tr>
</tbody>
</table>
General Fund

The General Fund of the U.S. Treasury also provides resources for the Agency’s Operations account. In FY 2016, it accounted for $1.9 billion of the $9.9 billion appropriated to that account. Over the past ten years, the General Fund appropriation has ranged from a low of $1.1 billion in FY 2015 to a high of $5.4 billion in FY 2010.

A funding option would be to consider the UAS industry an “infant industry” in need of special protections. The infant industry argument for tax (or regulatory) relief is typically invoked in cases where a nation sees the existence of potentially large external benefits from the growth of an industry, or the potential for other important non-economic benefits. With this consideration, Congress would need to be asked for additional General Fund support explicitly for the FAA’s UAS-related resource requirements in the absence of any kind of tax or fee revenues from UAS.

Charging Mechanisms

The Congressional Budget Office defines a user fee as “money that the Federal Government charges for services or for the sale or use of federal goods or resources that generally provide benefits to the recipients beyond those that may accrue to the general public.” User fees assign
part, or all of the costs, of programs and activities to readily identifiable users of those programs and activities.

One purpose for having user fees as a funding mechanism is equity, as they help ensure that government services are paid for— at least partly— by those who use them. A principal advantage of user fees over many other funding mechanisms is that they may foster production efficiency by increasing awareness of the costs of publicly provided services and therefore increase incentives to reduce costs where possible. One challenge of user fee funding is that this method may have difficulty achieving revenue adequacy if the basis of cost recovery relies on historic costs and the costs of providing services increase over time.

The FAA currently collects a variety of fees: overflight fees, registration fees, and aeronautical information services (aeronautical charting products) fees. The FAA also collects fees for the services of Flight Standards Service (AFS) Aviation Safety Inspectors (ASI) outside the United States; these fees recover the costs of certification services and approvals. Overflight fees are charges for costs of providing air navigation services for aircraft flights that transit U.S.-controlled airspace, but neither land in nor depart from the United States. The FAA charges separate fees for en route and oceanic airspace services; the fees charged reflect FAA cost accounting and air traffic activity data. Overflight fees fund the Department of Transportation's Essential Air Services program and do not support any FAA activities or operations.

The FAA also charges fees for aircraft registration and airmen (replacement) certification. The current fees were established in the 1950s and 1960s and have never been updated. Under the 2012 FAA Reauthorization, the FAA was directed by Congress to update fees and to begin charging fees for three additional activities (airmen certificates, airmen medical certificates, and legal opinions related to aircraft registration). At the present time, the FAA is in rulemaking to establish new and updated fees.

Since 1926, the Federal Aeronautical Charting Program has been a fee-based service. Congress transferred the program from the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) to the FAA in October 2000. Public Law 106-181, dated April 5, 2000, provided for the FAA to charge user fees to recover the full costs of the compilation, production and distribution of both electronic and paper charts. Recently, with the rise of digital formats for our navigation and charting products and the corresponding reduction in paper sales, the Agency has faced challenges in fully recovering these costs.

In comparison with fees, a tax has the primary purpose of raising revenue. Taxes are unrequited in the sense that benefits provided by the government to taxpayers are not normally in proportion to their payment. Tax represents revenue that a government collects; such revenue typically comes from an individual or business when they perform a particular action or complete a specific transaction. Such a tax is often assessed as a percentage of an amount of money involved in the transaction e.g., a tax is often placed on the sale of goods or services, such as the aviation excise taxes explained above.

Sometimes the line between user fees and taxes is blurred, as in the case of federal gasoline excise taxes being used to fund the Interstate Highway System. This tax system is based on the
“user pays” principle in which the costs of the construction and maintenance of roadways are paid by the individuals and firms that use and benefit from the service through taxes. Like user fees, Congress can—and sometimes does—choose not to make the full amount of taxes available to a Federal agency for expenditure and the balances in a dedicated trust fund (like the Aviation Trust Fund) may accumulate and go unspent.

UAS users and operations could be taxed for FAA services in varied ways. For example, a UAS purchaser could incur a sales excise tax with the rationale that there is a likely to be a tie-in between the expected future operations of the UAS and the use of government (FAA) services. Alternatively, an excise tax could be levied on the price paid for commercial services rendered by UAS operations. This tax could be analogous to the excise tax on the price paid for the transportation of domestic air cargo. Either of these taxes (a tax on the good purchased or a tax on the service provided) would require new, and potentially, substantial federal tax administration.

**Implementation Considerations**

Legislative authority is required in order to provide federal revenue through user fees, taxes or the General Fund. Taxes generally fall under the jurisdiction of the tax committees, while user fees can be handled through authorizations and/or appropriations. For many years, the FAA has had an annual appropriations law prohibition on instituting new user fees, which would need to be addressed. In addition, obtaining new funding from Congress involves navigating its inherent political nature and political challenges.

Congress could set fees in statute but rulemaking may be necessary if Congress is not prescriptive enough or establishes cost-recovering user fees. For example, the FAA is currently promulgating rules updating overflight fees and for establishing new and updated aircraft and airman registry fees. If user fees are established, the FAA would most likely be the billing and collection agency for the fees. Federal excise sales taxes are administered by the Internal Revenue Service (IRS).

Fees and taxes can also change behaviors by creating disincentives or friction. For example, a transaction-based fee charged as a condition of receiving a specific service may cause people to avoid the service. This is undesirable for fees that have potential safety implications. In contrast, a point-of-sale retail tax appears to the user as essentially bundled into the retail price, and so appears simple. Its impact on the purchase decision will be influenced by its size relative to the purchase price and the overall price sensitivity of the purchaser.

Any funding mechanism will have impacts on those charged as well as practical considerations for implementation. The administrative burdens vary both for entities paying and charging. There are costs and time processes associated with establishing and collecting fees, as well as with enforcing compliance. As UAS are further integrated into the NAS, industry environment will continue to change along with the regulatory landscape. The funding solution needs to be flexible and scalable to accommodate these changes.
Lastly, options for a funding structure for UAS should not be constrained by the current traditional aviation funding structure. At the same time, as funding structure for UAS should not be expected to alter the current structure of funding for traditional aviation.
Celebrating 75 Years of Federal Air Traffic Control

By: Theresa L. Kraus, Ph.D.
Agency Historian, Federal Aviation Administration

(On July 6, 1936, the Department of Commerce’s Bureau of Air Commerce began federal control of en route traffic to improve system safety. Federal control not only lead to a new government enterprise, but also to a new profession – air traffic control. Federal takeover of airport traffic control began on November 1, 1941.)

By the mid-1930s, the fledgling airline business in the United States experienced a period of tremendous growth. The introduction of the Boeing 247 in 1933, Douglas DC-2 in 1934, and the DC-3 in 1936, with enhanced performance and passenger comfort, helped stimulate interest in air travel. As the Bureau of Air Commerce pointed out:

Such inducements as berths for night flights, sound-insulated cabin walls, precooled or preheated air in the passenger compartment help to sway the traveler’s mind toward a decision in favor of scheduled air transportation . . . Increases in the speeds of multi-engined transport craft from the neighborhood of 100 miles an hour to rates approaching 200 miles an hour . . . wing flaps . . . adjustable pitch propellers . . . geared engines . . . help to account for this acceptance of air transportation.¹

With a greater demand for air transportation, regularly scheduled service became commonplace at the nation’s large airports. The number of air passengers on U.S. domestic carriers increased from 461,743 in 1934, to an estimated 1,900,000 in 1939.²

By the mid-1930s, Newark and Chicago had become the busiest airports in the country

¹ “Scheduled Air Transportation in 1934,” Air Commerce Bulletin, vol. 6, no. 4 (July 15, 1934), pp. 4-6.
with airport controllers handling 50-60 operations per hour during peak periods. The controllers, employed by the local airport, provided the pilots clearance to land. With no en route control, pilots waiting for clearance had to keep their plane separated from other aircraft. With so many planes attempting to land at the same time and place, near misses became typical in terminal areas, especially in inclement weather. With safety threatened, many in the federal and local government, military, and civil aviation communities began to call for air traffic control that extended beyond the airport to help coordinate the orderly flow of traffic into terminal areas.

To study options for en route control, the Bureau of Air Commerce held a series of meetings with the aviation community, beginning in April 1935. In its first meeting, on April 8, Bureau personnel met with airline operators to discuss a number of concerns. The attendees recommended the Bureau undertake a study of the existing air traffic situation to determine the best method for dealing with en route air traffic control and the mid air collision hazard. In September, the Bureau met with representatives from the Army, Navy, Marine Corps, and Coast Guard. The military, in agreement with industry, called for a system of uniform air traffic control and compliance.³

While the Bureau studied possible solutions, some airlines, including TWA, United, and American, developed inter-airline safety agreements to enhance safety on heavily traveled air routes, such as the Chicago-Newark airway, and at congested airports. The Bureau approved the first such agreement on September 26, 1935;⁴ approval of similar agreements among airlines on other routes followed.⁵ Since not all operators were party to these agreements, the Bureau issued

⁵ See, for example, “Interline Safety Agreements Approved by Department of Commerce,” *Air Commerce Bulletin*, vol. 7, no. 8 (February 15, 1936), pp. 192-195 and “Interline Safety Agreements Approved by Department of Commerce,” *Air Commerce Bulletin*, vol. 7, no.10 (April 15, 1936), pp. 248-149.
a “Notice to All Pilots and Operators” on November 1, 1935, that temporarily prohibited airway users from instrument flying in the vicinity of airways and terminals. The Bureau issued a modified notice fourteen days later that stipulated, until it passed regulations to govern airway traffic control:

1. No pilot shall make an intentional instrument flight in broken clouds or solid overcast within 25 miles of the center line of those legs of radio beams regularly used as airways, or within 25 miles of an air line airport.

2. Instrument flying under simulated conditions (under hood) for training purposes may be conducted, providing a safety pilot having unobstructed vision and with access to the controls of the aircraft accompanies the flight, and provided further, that such flight does not enter broken cloud formation or overcast within the foregoing prescribed limits of airports or airways.

3. Commanding officers of Army, Navy, Marine Corps, and Coast Guard units utilizing radio ranges and airport facilities for instrument training purposes are cooperating, issuing regulations for the guidance of their pilots. These regulations will be formulated after consultation with the operating managers of the air lines and airport concerned and will be such that definitely precludes any possibility of collision with scheduled air line aircraft.

4. Scheduled air lines operating under letters of authority, or any aircraft carrying two-way communication equipment with a minimum range of 25 miles . . . which demonstrates capability of such operations by communication with point of departure control tower or Department of Commerce radio station at time of leaving are not affected by this order.

5. When aircraft other than air line make any flight under these conditions, the pilot shall communicate, if possible, with all Department of Commerce stations on his route at regular intervals throughout the flight. These privileges shall not be extended to include any practice flights.

6. Any other pilot other than air line taking advantage of these provisions shall submit flight information to point of departure control tower or Department of Commerce radio station, which will teletype such information in the form of a PX [position] report confirming his flight plan or informing them of any change.

---

Director of Air Commerce Eugene Vidal hosted an aviation conference on November 12-14, 1935, to discuss airway traffic control. The conferees recommended that a group of federal employees, to be called flight control officers, be located at strategic points along the federal airways to prevent “traffic confusion which might result in collisions.” These flight control officers would “direct and coordinate the progress of all flights” over the federal airways to ensure their safe and orderly arrival at airports “thus preventing serious congestion and the resultant confusion around busy airports.” In addition, they suggested that flight control officers be stationed at Chicago, Cleveland, Newark, Detroit, Pittsburgh, and Washington, DC.8 Airport operators would continue to have responsibility for air traffic control at their airports.

Although a lack of funding prevented the Bureau of Air Commerce from assuming immediate control of the airways, Vidal convinced the airline operators to establish airway traffic control immediately. He promised that in 90 to 120 days the Bureau would take over the operations. Hence, on December 1, 1935, a consortium of airline companies organized and manned the first airway traffic control station at Newark, NJ. Center employees, hired by the airlines, provided information to airline pilots on the location of airline aircraft other than their own during weather conditions requiring instrument flying. Two additional centers, similarly organized and staffed, opened several months later: Chicago, IL (April 1936) and Cleveland, OH (June 1936).

In preparation for the Bureau to take over of the new airway traffic control stations, on

---

March 6, 1936, Vidal hired Earl Ward to supervise airway traffic control. Ward, born in 1895, had a long aviation career. He had served as a Marine Corps pilot, before joining the Curtiss Aeroplane & Motor Company as a test and exhibition pilot. He had also worked as a mail service pilot for the Post Office Department and for National Air Transport. Prior to coming to the Bureau of Air Commerce he had been a pilot with American Airlines and had served as the airline’s air traffic coordinator at Newark.9

Nonetheless, Bureau of Air Commerce officials seemed unsure if they could obtain the necessary resources to take over the stations within its promised timeframe. In fact, shortly after he came to the Bureau, Ward wrote his supervisor urging that “funds should be made available at once to enable the formative work to go forth.” He said:

The fact that there have been no major disasters caused by collision in the air has so far been a matter of luck rather than forethought, and I cannot urge too strongly, basing my statement on first-hand knowledge, that the Bureau of Air Commerce move in on this problem with the utmost speed, as the consequences of such a collision would provoke . . . a storm of comment and criticism such as never been seen before.10

The Bureau did find funding, and on July 6, 1936, federal air traffic control began as the Bureau of Air Commerce took over operation of the three airway traffic control stations at Newark, Chicago, and Cleveland. In explaining the reasons for the take over, the Bureau said:

Traffic control is more urgently needed when the aircraft along the airway are flying in or above fog and clouds and are being navigated by instruments and radio. At such times it is especially necessary that aircraft be kept adequately separated, either horizontally or vertically or both, so that there can be no possibility of a collision.11

Earl Ward, who reported to the chief of the Airline Inspection Service within the Bureau’s Air

Regulation Division, supervised the centers. Ward hired the fifteen existing airway traffic station employees to become the original federal corps of airway controllers. These pioneers were:

- Homer F. Cole
- H. D. Copland
- William H. Cramer
- R. A. Eccles
- Glen A. Gilbert
- John L. Huber
- Hugh McFarlane
- Emerson R. Mehrling
- L. Ponton de Arce
- C. J. Stock
- R. E. Sturtevant
- J. V. Tighe
- C. T. Tolpo
- Lee Warren
- E. A. Westlake

These men, according to the Bureau, were “laying the foundation for what promises to become a vital part of flight operations throughout the country.”

When the airlines ran the airway traffic stations, the controller’s only kept en route airline traffic separated and flowing in a manner so that it arrived at terminal areas in an orderly fashion. When the Bureau took over operation of the stations, however, it recognized it needed to control all traffic flying on instruments. As Ward explained, “We have been prone, perhaps subconsciously, to think of air transports when air traffic control is mentioned.” He pointed out, however, “the safety of passengers in and operations of other than scheduled air transports must be given consideration . . . An air transport . . . can be jeopardized by lack of supervised control of an operator of any other aircraft.” Safety, according to Ward, required that all flights “proceed

---

from origin to destination in a prescribed manner.”

Upon the recommendation of Ward and others, the Bureau issued a set of regulations, effective August 15, 1936, that required all civil pilots desiring to fly intentionally by instruments over a civil airway to have an instrument rating and a federally licensed aircraft equipped with two-way radio and approved instrument flying equipment. Pilots were required to file a flight plan if they intended to fly by instruments or along a civil airway when visibility was less than one mile. Military pilots flying by instruments had to have equivalent qualifications to their civilian counterparts and equivalent equipment on their aircraft. Since, at this time, almost all general aviation pilots lacked instrument ratings and equipment for instrument flying, the new rules generally kept them off airways used by air carriers.

The pioneer controllers had responsibility for controlling instrument flights between the time the aircraft left the jurisdiction of one terminal area and entered the jurisdiction of another. They resolved any conflicts that arose between these aircraft and those flying visually. Their authority ended only when an aircraft came within the tower operator’s visual range.

The controllers manually operated this first generation air route system. Unlike tower operators, en route controllers could not communicate directly with pilots. Airline company dispatchers relayed information or instructions between pilots and the controllers. Information about other aircraft – private, military, and nonscheduled commercial – reached the controllers from the Department of Commerce’s communications stations by way of radio or teletypewriter circuit.

The en route controller only exercised positive control on aircraft flying by instrument,

---

14 Earl Ward to Hugh Smith, July 1, 1937 and Earl Ward to Colonel Cone, June 29, 1936, both quoted in Bonfires to Beacons, pp. 311-312.
and the Bureau only required instrument flight when weather conditions demanded it. The controllers, however, did monitor the progress of all aircraft along the airway, even in good weather, so they could alert pilots to other aircraft within 15 minutes or less of their line of flight as well as the estimated time and altitude these aircraft would pass over designated points.

To track aircraft, controllers posted incoming flight information on a large blackboard, which could be revised as they received new reports on takeoffs, en route progress, and landings. They transferred the blackboard information to a large table map that depicted all airways converging on the terminal area they monitored. Controllers placed small wooden markers, shaped like shrimp boats, on the face of the map. Each marker represented a flight in the station’s control area. The shrimp boat indicated the position of an aircraft, and each came equipped with a clip that held a strip of paper that controllers used to record the flight’s identity, time of departure, and altitude. The controller moved the markers every fifteen minutes to indicate visually the estimated progress of the aircraft.16

By looking at the shrimp boats on the map, a controller could see the traffic along the routes he controlled and detect potential conflicts. If he discovered a conflict, he picked up the phone and told the airline company dispatcher to instruct his pilot to go to a different altitude, circle around a radio fix, or look out and avoid any non-instrument flights in the vicinity. The en route controller also coordinated operations with the tower controller to ensure an orderly flow of traffic into the

---

16 “Airplane Movements Along Airways Correlated by Traffic Control System,” pp. 31-38; Bonfires to Beacons, p. 311.
Staffing at each airway control station included a manager, assistant manager, and three controllers. The stations originally operated 16 hours a day, from 8:00 a.m. until midnight, but soon went to a 24-hour schedule because of increasing demand for service. The largest on-duty contingent present at the station during periods of heaviest traffic was three, the smallest contingent one. Each station came equipped with a blackboard, a large table map, a teletype machine, and a telephone.

When three controllers were on duty, each performed a distinct function. The so-called “A” controller issued all necessary instructions to aircraft, including clearances, and maintained the dispatch board and the inbound flight log. The “B” controller, or coordinator, handled the weather information, maintained two other logs, and positioned the shrimp boats on the map. The “C” controller, or calculator, estimated the speed of incoming aircraft and the time they would arrive over designated fixes, and wrote that information on the blackboard. During periods of low activity, one person handled all duties. When two controllers were on duty, they split the job of coordinator.

The Bureau maintained stringent requirements for its controller recruits. They had to have a high school diploma, plus one of the following: 1,000 hours flying time; one year’s experience in an airline operations office; or experience in controlling traffic. When the controllers came under civil service rules the Bureau dropped the education requirement. Despite some early rumors that manager salaries ranged from six to eight thousand dollars per annum and a private plane came with the job, in reality, an airway traffic control station manager earned

---

18 Ibid., pp. 11-12.
19 Bonfires to Beacons, p. 311.
$3,500 per year with no plane, an assistant manager $2,900, and a controller $2,000.\textsuperscript{20}

The Bureau quickly expended the number of airway traffic control stations. On October 19, 1936, the Bureau announced establishment of a new airway control station at Detroit, MI.\textsuperscript{21} It subsequently established stations at Pittsburgh, PA (November 16, 1936); Los Angeles, CA (February 9, 1937); Washington, DC (April 1, 1937); and Oakland, CA (May 15, 1937). By the end of 1939, the number of stations totaled 12 with the addition of Fort Worth, TX (March 1, 1939); Salt Lake City, UT (April 1, 1939); St. Louis, MO (May 1, 1939); and Atlanta, GA (October 1, 1939).\textsuperscript{22}

The rapid expansion of airway traffic control services created manpower shortages at the stations, and the inability to hire a sufficient number of controllers took its toll on the workforce. Workload demands required managers to schedule controllers beyond their standard 44-hour work week. For example, at the understaffed Detroit station, controllers worked a split shift and those who lived a considerable distance from the airport sometimes spent 13 hours a day at the station. In addition, working conditions were far from optimal – the original stations were generally in small and noisy makeshift spaces at an airport. As one former controller reminisced, “there was no such thing as overtime [pay] or complaining.”\textsuperscript{23} As a result, controllers began showing signs of fatigue and stress. As the assistant Detroit station manager, C. W. Schott wrote:

It appears logical to assume that those of us engaged in the work are subject to fatigue at certain times. Since fatigue is defined as that state when an individual is capable of less general activity (physical and mental) than would be expected . . . and since the symptoms are lack of interest, inattentiveness, irritability, and a general tired feeling, it is logical to assume that every possible step should be taken to limit the fatigue stimuli in an

\textsuperscript{20} Bonfires to Beacons, p. 317.
\textsuperscript{22} FAA Historical Chronology, 1926-1996, http://www.faa.gov/about/history/chronology_history/.
\textsuperscript{23} C. W. Schott to Manager, Detroit Airway Traffic Control Station, February 10, 1938, quoted in Bonfires to Beacons, p. 323.
Initially, in addition to insufficient work spaces and long hours, the early controllers found themselves doing more than controlling traffic. Prior to 1938, the Bureau of Air Commerce did not provide the stations with logistical or engineering support. Thus, each station relied on its staff and local suppliers for equipment design and fabrication. In fact, the first controllers, in a very real sense, created the first-generation air traffic control system they used. For example, Glen Gilbert helped develop the first-generation procedures and wrote the first air traffic control manual. J. V. Tighe designed the first satisfactory shrimp boat, fabricated out of brass. John Huber proved instrumental in the design of the first telephone recording equipment and developed the first flight-progress board, which eventually replaced the blackboard. Lee Warren worked with an engineer to design a standard control station.25

In December 1938, the Bureau’s successor agency, the Civil Aeronautics Authority (CAA), changed the name of the en route facilities from airway traffic control stations to airway traffic control centers. With the outbreak of World War II in Europe in 1939, and with the United States gearing up for and eventually entering the war, the CAA began established a number of new centers. (See Table 1.)

Like most federal agencies, the CAA prepared for the impending conflict. In addition to its normal duties of airway development, air traffic control for en route flight, and certification of

24 Ibid.
airmen and aircraft, since 1939, the CAA had also managed the Civil Pilot Training Program designed to bolster national power by building a reservoir of aeronautical skill. In 1940, the CAA had received its first direct Congressional appropriation for airport development.

By the fall of 1941, the CAA had expanded its airway traffic control system, with two new centers at Seattle and Cincinnati nearing completion for a total of 14. The work of en route controllers remained more narrowly focused than that of tower controllers, who worked directly for their airport’s management – usually a municipal authority. Responsible for flights within three miles of the runway, the tower operators relied heavily on visual observation. They communicated with pilots by voice broadcasting or, when aircraft did not have radios, by light signals.

The Civil Aeronautics Act of 1938, which created the CAA, mandated the new agency certify airport traffic controllers, a requirement that lead to establishment of basic standards for physical condition, theoretical knowledge, and experience. The CAA tried, with only limited success, to promote uniformity of equipment and techniques. The Air Traffic Control Section’s manager, Fred Smith, had commented on the need for a closer connection between the airport and airway control systems in a memorandum written shortly before the war began in Europe. He discussed options under which the government might trade material assistance to the municipal airports for greater oversight of air traffic control activities. While recognizing that outright federalization would boost standardization and efficiency, Smith foresaw problems that included friction with local authorities, loss of towers as sources of municipal pride, and a major increase in federal liability for accidents.26

<table>
<thead>
<tr>
<th>Center</th>
<th>Commissioned</th>
<th>Decommissioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago</td>
<td>July 6, 1936</td>
<td>N/A</td>
</tr>
<tr>
<td>Cleveland</td>
<td>July 6, 1936</td>
<td>N/A</td>
</tr>
<tr>
<td>New York</td>
<td>July 6, 1936</td>
<td>N/A</td>
</tr>
<tr>
<td>Detroit</td>
<td>October 19, 1936</td>
<td>July 5, 1964 – functions transferred to Cleveland center</td>
</tr>
<tr>
<td>Pittsburgh</td>
<td>November 16, 1936</td>
<td>October 21, 1962 – functions transferred to Cleveland center</td>
</tr>
<tr>
<td>Los Angeles</td>
<td>March 1, 1937</td>
<td>N/A</td>
</tr>
<tr>
<td>Washington</td>
<td>April 1, 1937</td>
<td>N/A</td>
</tr>
<tr>
<td>Oakland</td>
<td>May 15, 1937</td>
<td>N/A</td>
</tr>
<tr>
<td>Fort Worth</td>
<td>March 1, 1939</td>
<td>N/A</td>
</tr>
<tr>
<td>Salt Lake City</td>
<td>April 1, 1939</td>
<td>N/A</td>
</tr>
<tr>
<td>St. Louis</td>
<td>May 1, 1939</td>
<td>July 1, 1964 – functions transferred to Kansas City center</td>
</tr>
<tr>
<td>Atlanta</td>
<td>October 1, 1939</td>
<td>N/A</td>
</tr>
<tr>
<td>Seattle</td>
<td>October 1, 1940</td>
<td>N/A</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>November 11, 1940</td>
<td>September 1, 1954 – when Indianapolis center was commissioned</td>
</tr>
<tr>
<td>Boston</td>
<td>December 7, 1941</td>
<td>N/A</td>
</tr>
<tr>
<td>Jacksonville</td>
<td>December 15, 1941</td>
<td>N/A</td>
</tr>
<tr>
<td>Memphis</td>
<td>January 15, 1942</td>
<td>N/A</td>
</tr>
<tr>
<td>Kansas City</td>
<td>February 1, 1942</td>
<td>N/A</td>
</tr>
<tr>
<td>San Antonio</td>
<td>February 15, 1942</td>
<td>July 10, 1965 – functions transferred to Houston center</td>
</tr>
<tr>
<td>Albuquerque</td>
<td>March 1, 1942</td>
<td>N/A</td>
</tr>
<tr>
<td>Denver</td>
<td>March 1, 1942</td>
<td>N/A</td>
</tr>
<tr>
<td>Great Falls</td>
<td>March 15, 1942</td>
<td>June 16, 1976</td>
</tr>
<tr>
<td>Minneapolis</td>
<td>March 15, 1942</td>
<td>N/A</td>
</tr>
<tr>
<td>Anchorage</td>
<td>September 15, 1943</td>
<td>N/A</td>
</tr>
<tr>
<td>Fairbanks</td>
<td>October 14, 1943</td>
<td>January 1975 – functions transferred to Anchorage center</td>
</tr>
<tr>
<td>Honolulu</td>
<td>January 15, 1944</td>
<td>N/A</td>
</tr>
<tr>
<td>Miami</td>
<td>August 16, 1944</td>
<td>N/A</td>
</tr>
<tr>
<td>New Orleans</td>
<td>October 1, 1945</td>
<td>June 26, 1965 – functions transferred to Houston center</td>
</tr>
<tr>
<td>El Paso</td>
<td>October 1, 1946</td>
<td>June 22, 1963 – functions transferred to Albuquerque center</td>
</tr>
<tr>
<td>San Juan</td>
<td>December 1, 1948</td>
<td>N/A</td>
</tr>
<tr>
<td>Wake Island</td>
<td>August 1, 1950</td>
<td>December 7, 1967 – functions transferred to Honolulu center</td>
</tr>
<tr>
<td>Norfolk</td>
<td>May 5, 1952</td>
<td>June 30, 1963 – functions transferred to Washington center</td>
</tr>
<tr>
<td>Indianapolis</td>
<td>September 1, 1954</td>
<td>N/A</td>
</tr>
<tr>
<td>Spokane</td>
<td>April 22, 1957</td>
<td>April 4, 1963 – functions transferred to Seattle center</td>
</tr>
<tr>
<td>Phoenix</td>
<td>April 19, 1958</td>
<td>August 20, 1964 – functions transferred to Albuquerque center</td>
</tr>
<tr>
<td>Guam</td>
<td>June 1, 1959</td>
<td>N/A – now designated a center/approach control facility</td>
</tr>
<tr>
<td>Balboa</td>
<td>July 1, 1961</td>
<td>FAA phased out all its facilities in Panama between October 1979 and April 1983</td>
</tr>
<tr>
<td>Houston</td>
<td>June 26, 1965</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Source: Appendix 5, *FAA Historical Chronology*
The importance of such obstacles diminished as America drew closer to entering the war. Advocates of ramp-to-ramp federal control under CAA leadership included the Interdepartmental Air Traffic Control Board, established to cope with the burgeoning demands of military and defense-related aviation. The legislation creating CAA had already given the agency authority to take over airport traffic control, and the military services favored the action. Congress needed only to provide funding, which it did in an August 25, 1941, appropriation that earmarked $1 million of the defense budget for CAA operation of towers designated as essential by the War and Navy Departments.27

In September 1941, the CAA announced that it would assume traffic control at 39 airfields heavily used by military planes. The move provoked little or no grassroots opposition. In fact, a writer in *American Aviation* speculated that the municipalities might not be eager to resume responsibility for their towers after the war.28 The CAA takeover began on November 1, starting with the Navy’s Floyd Bennett Field, NY, and seven civil airports in Albuquerque, NM; Atlanta, GA; Charlotte, NC; Orlando, FL; Portland, OR; Salt Lake City, UT; and Savannah, GA. By mid-month, these seven sites had become the first commercial airports with federal air traffic services (except for the CAA-operated Washington National, which had opened that summer).29

In 1941, prior to CAA takeover of towers,

---

29 *FAA Historical Chronology*. 
approximately 150 controllers manned towers across the country. With the U.S. gearing for war, more and more men left the CAA to join the war effort. With a new personnel policy that stated “no person shall be selected for employment in the CAA who is eligible for military service,” the agency faced the possibility of critical personnel shortages. The need to staff the towers resulted in a formidable recruiting effort. To prepare for an onslaught of new controller recruits, the CAA established seven training centers, one in each region in the continental United States (New York, Chicago, Atlanta, Kansas City, Fort Worth, Seattle, and Santa Monica), to instruct its new cadre of airport control operators. Each region did its own recruiting, hiring, training, and placement of personnel.

Training consisted of four weeks of theory, followed by “practice in the operation of an airport control tower and the supervision of air traffic into and out of an airport.” Initially, both female and male applicants had to be between the ages of 20 and 45, have a private pilot’s license, and 18 months of air traffic control experience or a high school or college education. New hires earned $1,800 per year, with advancement to $2,000 per year upon satisfactory completion of training, which usually took about six months.30

The Pearl Harbor attack on December 7, 1941, gave even more urgency to the CAA’s control of airport air traffic. By the end of fiscal year 1942, the agency operated 59 towers, and by the end of fiscal year 1944, operated 115. Once it took over a tower, the CAA quickly upgraded the equipment, introducing higher frequency radio, recording devices for air traffic instructions, and controllable tetrahedrons for indicating traffic direction. At locations where the airport controllers worked in inadequate structures, the agency built temporary towers according to a standard design.

Standardization became key to managing the increasing civil and military air traffic immediately prior to and during the war. As CAA officials pointed out:

Some of the advantages gained through C.A.A. control of local towers include the coordination of airport traffic control with the airway traffic control system . . . standardization of control procedures, practices, and equipment, and the establishment of uniformly high personnel performance as a result of national recruiting and training programs.31

Federalization produced the long-desired uniformity of air traffic procedures as the agency introduced new traffic patterns to create a more orderly flow on taxiways and in terminal airspace. Perhaps the most important innovation was the introduction of “approach control” to speed traffic at selected locations. Tower controllers could now reach beyond the immediate airport vicinity to issue radio guidance for aircraft seeking to land under instrument flight rules. In situations where “stacked” aircraft had previously been able to land at a rate of one every 12 minutes, approach control permitted a landing every five minutes.32

As the military use of civil airports declined in 1945, the War and Navy Departments’ underwriting of the CAA’s airport control activities declined. The agency returned some towers to local jurisdiction, and, in a few cases, accepted municipal reimbursement for the service. In fiscal year 1947, however, Congress replaced the dwindling military support with the first of

---

many direct appropriations. The initial funds allowed the CAA to operate 90 towers full-time, and 20 others part-time. The ramp-to-ramp system, its advantages made obvious during the war, became a permanent national asset.
Transportation including aviation have been subject to special taxes (fuel, tires, oils, etc.) for decades. Originally those taxes were not dedicated to transportation purposes.

The Revenue Act of 1932 which imposed the first federal gas tax and reimposed taxes on oil lubricants, tires, and inner tubes specifically included aeronautical uses among other transportation uses subject to the taxes.

Excise taxes on the transportation of persons and property were imposed during the early 1940s as war revenue measures. These taxes were taxes on general transportation including aviation transportation. In subsequent years, tax legislation began setting precedents for separate taxes and separate rates for aviation related activities.

The revenues obtained from these taxes were not applied directly to airways expenditures. They were either earmarked for other purposes or went into the general fund of the Treasury.
Preparing for the future of air transportation

The ability to transport people and products by air—safely, surely, and efficiently—is a national asset of great value and an international imperative for trade and travel. That ability is being challenged today by insufficiencies in our nation's airports and airways. The demand for aviation services is threatening to exceed the capacity of our civil aviation system.

The proposed airport program consists of both an expanded planning effort and the provision of additional Federal aid for the construction and improvement of airports.

To provide for the expansion and improvement of the airway system, and for a high standard of safety, this Administration proposes that the program for construction of airways facilities and equipment is responsive to the substantial expansion in the operation and maintenance of the air traffic system in the next decade. Technology is moving rapidly and its adaptation to provide future solutions must keep pace. Consequently, this program includes a provision for a doubling of development funds.

However, the added burden of financing future air transportation facilities should not be thrust upon the general taxpayer. The various users of the system, who will benefit from the developments, should assume the responsibility for the costs of the program. By apportioning the costs of airways and airports improvements among all the users, the progress of civil aviation should be supported on an equitable, pay-as-we-grow basis.

The revenue and expenditure programs being proposed are mutually dependent and must be viewed together. We must act to increase revenues concurrently with any action to authorize expenditures; prudent fiscal management will not permit otherwise.

RICHARD NIXON
White House
June 19, 1970
Revenue passenger miles on U.S. domestic scheduled air carriers more than tripled from 1960 to 1970 and are projected to almost triple again from 1970 to 1980. From 1970 to 1980, total aircraft operations are expected to rise by 179 percent and total IFR aircraft handled at FAA air route traffic control centers are projected to increase by 86 percent. These growth indicators depict an urgent need to provide facilities to meet the demand for the use of the system.

To provide additional revenue for the financing of the increased Federal Government outlays for the expansion and the development of the airport and airway system, new and increased user taxes are necessary to pay for an increasing portion of the total Federal Government expenditures for the air transportation system. Without these user taxes the general taxpayer would be required to finance most of the cost of the system through general appropriations, if the need is to be met.

The Trust Fund is created in order to insure that the aviation user taxes are expended only for the expansion, improvement, and maintenance of the air transportation system.

•Report submitted by the Senate Committee on Finance--February 1, 1970
Establishing the Airport and Airway Trust Fund

• In 1970, Congress passed the Airport and Airway Development Act and the Airport and Airway Revenue Act. Congress initiated these two acts to deal with the inadequacy of the Nation’s airport and airway systems in meeting current and future projected growth in aviation. The Airport and Airway Trust Fund, also known as the Aviation Trust Fund, was enacted by the latter act and was effective on July 1, 1970.

• The Airport and Airway Revenue Act of 1970 authorized the aviation trust fund and aviation-related excise taxes to finance aviation. Taxes for the trust fund included the existing taxes on aviation gasoline and passenger tickets on domestic flights, and three new taxes, which were on international passenger tickets, air-freight waybills (transportation of property by air, i.e. cargo), and annual aircraft registration.
The Airport and Airway Trust Fund Evolves

• Debate over the proper use of the trust fund and what proportion could be spent on the operation and maintenance of the air traffic control system began almost immediately. Proposals by the Nixon Administration in 1971 to restrict capital spending from the trust fund, while fully funding FAA operations from it, led the Congress to restrict trust fund spending to only the capital costs of the aviation system, some administrative expenses, and research and development activities related to air navigation safety; use of trust funds for maintenance and operation of air navigation facilities was no longer permitted. Beginning in 1977, the trust fund was authorized to fund again a portion of FAA operations spending in addition to aviation capital requirements.

• The tax and fee structure and the rates charged have been modified on several occasions, most notably by the Taxpayers Relief Act of 1997. Among other changes, this Act added a flight segment (i.e., a single takeoff and landing) tax, a tax on the purchases of the right to award frequent flyer miles, and a reduction in the tax rate on passenger tickets on domestic flights (from 10% to 7.5%). Certain taxes are indexed to inflation.
Results:
Prioritized List of Activities to Support UAS Operations

Graph Value Key
Safety – 60%
Enabling Operations – 28%
Economic & Societal Benefit – 12%
# Appendix 7

## FAA Activity Priority Based on Decision Lens Value

<table>
<thead>
<tr>
<th>Priority</th>
<th>Activity</th>
<th>Lead Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pilot Certifications/Qualifications</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>2</td>
<td>Air Traffic Management – R&amp;D</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>3</td>
<td>Flight Standards Policies/Procedures</td>
<td>Government</td>
</tr>
<tr>
<td>4</td>
<td>Air Traffic Controls - Policies/Procedures</td>
<td>Government</td>
</tr>
<tr>
<td>5</td>
<td>Injury Severity – R&amp;D</td>
<td>Govt. &amp; Ind.</td>
</tr>
<tr>
<td>6</td>
<td>Rulemaking</td>
<td>Government</td>
</tr>
<tr>
<td>7</td>
<td>C2 &amp; Spectrum – R&amp;D</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>8</td>
<td>Separation</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>9</td>
<td>DAA Standards</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>10</td>
<td>Traffic Management System</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>11</td>
<td>Airports - Policies/Procedures</td>
<td>Government</td>
</tr>
<tr>
<td>12</td>
<td>Outreach/Communication</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>13</td>
<td>Airworthiness Certification</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>14</td>
<td>Authorization Portal</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>15</td>
<td>Operators</td>
<td>Government</td>
</tr>
<tr>
<td>16</td>
<td>ATC Systems/Capabilities</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>17</td>
<td>C2 Standards - Standards</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>18</td>
<td>CNS Systems</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>19</td>
<td>Air Traffic Control - Training</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>20</td>
<td>Flight Standards - Training</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>21</td>
<td>Human Factors – R&amp;D</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>22</td>
<td>Airspace Charting</td>
<td>Government</td>
</tr>
<tr>
<td>23</td>
<td>Registration System</td>
<td>Government</td>
</tr>
<tr>
<td></td>
<td>Size/Impact Energy</td>
<td>Government</td>
</tr>
<tr>
<td>---</td>
<td>-------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Spectrum Management</td>
<td>Government</td>
</tr>
<tr>
<td>26</td>
<td>AVS/AVO Oversight</td>
<td>Government</td>
</tr>
<tr>
<td>27</td>
<td>Airports - Training</td>
<td>Government</td>
</tr>
<tr>
<td>28</td>
<td>Environmental – R&amp;D</td>
<td>Gov’t. &amp; Ind.</td>
</tr>
<tr>
<td>29</td>
<td>Environmental - Standards</td>
<td>Government</td>
</tr>
</tbody>
</table>