U.S. Department
of Transportation

**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

July 25, 2013

The Honorable John D. Rockefeller, IV
Chairman, Committee on Commerce, Science,
and Transportation
United States Senate
Washington, DC 20510

Dear Mr. Chairman:

As requested in Section 910 of Public Law (PL) 112-95, FAA Modernization and Reform Act of 2012, I am pleased to provide you with the aviation fuel research and development report.

We have sent identical letters to Chairman Smith, Senator Thune, and Congresswoman Johnson.

Sincerely,

Michael P. Huerta
Administrator

Enclosure

U.S. Department
of Transportation

**Federal Aviation
Administration**

Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

July 25, 2013

The Honorable John Thune
Committee on Commerce, Science, and Transportation
United States Senate
Washington, DC 20510

Dear Senator Thune:

As requested in Section 910 of Public Law (PL) 112-95, FAA Modernization and Reform Act of 2012, I am pleased to provide you with the aviation fuel research and development report.

We have sent identical letters to Chairmen Smith and Rockefeller and Congresswoman Johnson.

Sincerely,

Michael P. Huerta
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Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

July 25, 2013

The Honorable Lamar Smith
Chairman, Committee on Science, Space,
and Technology
House of Representatives
Washington, DC 20515

Dear Mr. Chairman:

As requested in Section 910 of Public Law (PL) 112-95, FAA Modernization and Reform Act of 2012, I am pleased to provide you with the aviation fuel research and development report.

We have sent identical letters to Chairman Rockefeller, Senator Thune, and Congresswoman Johnson.

Sincerely,

Michael P. Huerta
Administrator

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**Federal Aviation
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Office of the Administrator

800 Independence Ave., S.W.
Washington, D.C. 20591

July 25, 2013

The Honorable Eddie Bernice Johnson
Committee on Science, Space, and Technology
House of Representatives
Washington, DC 20515

Dear Congresswoman Johnson:

As requested in Section 910 of Public Law (PL) 112-95, FAA Modernization and Reform Act of 2012, I am pleased to provide you with the aviation fuel research and development report.

We have sent identical letters to Chairmen Smith and Rockefeller and Senator Thune.

Sincerely,

Michael P. Huerta
Administrator

Enclosure

Aviation Fuel Research and Development Report

as required by the FAA Modernization and Reform Act of 2012,
Pub. L. No. 112-95, Sec. 910

Section 910 Aviation Fuel Research and Development Program Report

1.0 Introduction

In accordance with the requirements of the FAA Modernization and Reform Act of 2012, Section 910, Aviation Fuel Research and Development Program, this report provides a summary of the Federal Aviation Administration's (FAA) effort to identify, test and qualify the best performing unleaded aviation fuel available and to safely transition the fleet of piston engine aircraft to that fuel. This report was developed in conjunction with the Section 910 Aviation Fuel Research & Development (R&D) Plan that was also required by this same Act (see section 5.0 and Appendix A of this report). It includes information on research and development activities, information obtained in collaboration with industry stakeholders, and policies and guidelines developed by the FAA to implement the transition.

In 2010, the FAA established a performance metric to make a replacement fuel for leaded aviation gasoline that is usable by most general aviation aircraft available by 2018. As a result, the FAA formed the Unleaded Aviation Gasoline (Avgas) Transition Aviation Rulemaking Committee (UAT ARC) to provide the FAA with recommendations to transition from 100 octane low lead avgas (100LL) to an unleaded avgas. The UAT ARC final report recommendations directly support the requirements of Section 910. Previous R&D efforts in the avgas area have focused on investigating the interaction of various chemical and metal additives with various base fuel formulations. Over the last 20 years, FAA research focused on facilitating industry evaluation of unleaded aviation gasoline alternatives with the ultimate goal of replacing 100LL with an unleaded fuel with identical performance properties, i.e., a drop-in fuel. The R&D plan outlined in this report is now focused on utilizing the collective knowledge of industry and our previous R&D efforts. The goals are to identify the fuel(s) with the least impact to the general aviation fleet irrespective of the drop-in objective, to develop fuel property data and engine and aircraft test data that can be utilized by the producer for fuel specification development and to certify the general aviation fleet to operate on these fuels.

2.0 FAA Aviation Fuel Research - Background

Avgas is a light, volatile fuel that is used in aircraft powered by piston engines. Avgas comes in several grades, the most common of which is called 100LL. The term "avgas" has traditionally been used to identify any grade or type of fuel intended for use on piston engine aircraft. Jet fuel is a heavier, less volatile kerosene-based fuel that is used by civil and military jet-powered aircraft.

Aviation fuel for both jet and piston aircraft engines has historically been made from petroleum. Recent environmental concerns with carbon footprint and economic concerns with price level and volatility have spurred the airline industry to investigate alternatives to petroleum-derived jet fuel. Fuels derived from bio-based feedstocks, such as plant oils, mitigate the carbon footprint of jet fuels to a great extent. The FAA Office of Environment and Energy (AEE) has played a key role in the evaluation and approval of "bio fuels" for use on jet aircraft. These bio-fuels are identical in composition and

performance to jet fuel derived from petroleum, and are therefore called drop-in fuels. These renewable fuels will significantly help the airlines offset their carbon footprint from engine emissions.

However, the challenges facing aviation fuel used in piston engines are different. Avgas use is small in comparison to jet fuel use, therefore carbon footprint is not the primary concern, but rather the use of tetra-ethyl lead (TEL) as an additive in avgas. The toxicity of TEL is well-established, and the use of this chemical has been declining over the last several decades, except for its use in 100LL. Therefore, the primary goal of the FAA's research has been to identify an avgas without lead, regardless of whether this fuel is made from petroleum or bio-based materials. The effort to transition to an unleaded avgas is being led by the FAA's Aircraft Certification Service (AIR).

The FAA's unleaded avgas research program at the William J. Hughes Technical Center (FAA Technical Center) was established in 1992 in response to the Clean Air Act of 1990. Prior to this, in the mid-1980s, the FAA Technical Center had been conducting research on General Aviation (GA) piston engines that did include some work on aviation fuels. In 1992 the FAA Technical Center created a collaborative program with industry under the Coordinating Research Council (CRC). While the ultimate goal was to replace 100LL with an unleaded avgas with identical performance properties, i.e., a drop-in fuel, the strategic direction taken by the group over the last 20 years has focused on facilitating industry evaluation of unleaded avgas alternatives. The bulk of the recent research investigated the interaction of various chemical and metal additives with various base fuel formulations.

The FAA Technical Center evaluated over 279 of these experimental formulations in laboratory experiments and on test engines. While none of these was found to be a drop-in replacement for 100LL, valuable data was developed describing the interaction of the tested additives and base fuels. While some of the blends appeared promising, all had performance or environmental shortfalls that made them unacceptable as drop-in replacement avgas. The FAA Technical Center research also included non-petroleum alternatives such as ethanol and Ethyl tertiary-Butyl Ether (ETBE). It is important to note that a significant amount of FAA R&D funding allocated for avgas research at the FAA Technical Center has been used for establishment of the engine and fuels testing facilities that have been used to support industry-funded research under Cooperative Research and Development Agreements (CRADA). The FAA and industry research enabled by these facilities has produced a body of work that will contribute to further avgas research efforts, and the facilities will continue to be useful in supporting future research.

3.0 Fuel Certification – Background

Historically, the commercial aviation industry has relied on a very limited number of well proven, conventional fuels for certification and operation of aircraft and engines. The vast majority of today's engines and aircraft were designed and certified to operate on one of two basic fuels: kerosene-based fuel for turbine powered aircraft and leaded avgas

for piston engine powered aircraft. These fuels are produced and handled as bulk commodities with multiple producers sending fuel through the national distribution system to airports and aircraft. These fuels are defined and controlled by industry consensus-based fuel specifications: in the United States, these are the American Society for Testing and Materials (ASTM) International D1655 for jet fuel and ASTM D910 for aviation gasoline. The industry and FAA members of the ASTM International aviation fuel committee work together to ensure these specifications provide the level of control of aviation fuel properties and quality to meet the demanding needs of civil aviation.

The evaluation and qualification process for a new fuel specification intended for existing aircraft and engines that are designed to operate on 100LL is complex. The process to evaluate new aviation gasoline is progressive and iterative in nature, with the extent of continued testing determined by the fuel properties, characteristics, and test results revealed at each stage. The extent of testing that may be necessary grows with an increasing degree of divergence from the composition, properties, performance, and experience with existing 100LL.

The FAA regulations pertaining to aircraft, engines, and aviation fuel rely on the aviation fuel specifications developed by the collaborative industry-FAA process utilized at ASTM International. The regulations require that type certificate applicants identify the fuel specifications that are used in their products during certification. The FAA does not directly regulate fuels, oils, lubricants, additives and other standard parts that are adequately controlled through the use of these industry standards. Once compliance with the airworthiness certification regulations has been demonstrated, the fuel grade designation or specification becomes part of the airplane, rotorcraft, and engine operating limitations. These operating limitations are specified in the type certificate data sheet (TCDS) and in the airplane flight manual (AFM), rotorcraft flight manual (RFM), and Engine Operating Instruction (EOI). Engine and aircraft manufacturers are required by 14 Code of Federal Regulations (CFR) §§ 33.7, 23.1583, 25.1583, 27.1583 and 29.1583 to specify the fuel specification as an operating limitation. Aircraft operators are then required by 14 CFR § 91.9 to only use fuels and oils specified by the engine and aircraft manufacturers as operating limitations. These fuels must, therefore, be identified with sufficient specificity to ensure that the engine and aircraft continue to meet their airworthiness certification basis during service.

4.0 Unleaded Avgas Transition Aviation Rulemaking Committee

The UAT ARC was chartered by the FAA Administrator on January 31, 2011[1]. The UAT ARC was tasked to investigate, prioritize, and summarize current issues relating to the transition to an unleaded avgas and to recommend the tasks necessary to investigate and resolve these issues. It was also tasked to provide recommendations for collaborative industry-government initiatives to facilitate the development and deployment of an unleaded avgas with the least impact on the existing piston engine aircraft fleet. The UAT ARC was comprised of key stakeholders from the general aviation community

[1] The UAT ARC charter is available at the following Web site: http://www.faa.gov/about/initiatives/avgas/mediaFiles/AvgasCharter.pdf.

including aviation trade/membership associations, aircraft and engine manufacturers, petroleum and other fuel producers, the Environmental Protection Agency (EPA), and the FAA.

The UAT ARC completed its final report on February 17, 2012[2]. The report contains five key recommendations (and 14 additional recommendations) to facilitate the transition to a replacement avgas. The recommendations build upon the FAA and industry experience gained over the last twenty years of research at the FAA Technical Center. That research provided a foundation of fuel chemistry and performance data that industry will utilize to develop candidate unleaded avgas fuels. The past research also resulted in FAA facilities and expertise which will support the testing and evaluation of these candidate avgas fuels to provide data for industry qualification and FAA certification. Although today the entire general aviation fleet can be operated on 100LL avgas, the industry and government research to date indicates that an unleaded replacement fuel will likely not satisfy the entire existing general aviation fleet without some engines and aircraft requiring modifications.

The UAT ARC recommended:

1) Implementation of the "Fuel Development Roadmap – Avgas Readiness Levels (ARL)" developed by the UAT ARC. The proposed Roadmap identifies the key milestones in the aviation gasoline development process and the information needed to support assessment of the viability of candidate fuels in terms of impact upon the existing fleet, production and distribution infrastructure, environment and toxicology, and economic considerations. [Note: This differs from previous efforts that focused on candidate fuel performance. This effort is more comprehensive and addresses performance, storage, transport, chemical interaction, etc., which were not considered in earlier research efforts. This effort will produce data to allow fuel producers to apply for certification of the fleet of aircraft that can be operated on the fuel without modification, referred to as the "transparent" fleet.]

2) Centralized testing of candidate unleaded fuels at the FAA Technical Center funded by Government and industry in-kind contributions. Centralized assessment and testing would generate standardized qualification and certification data that can be used by the fuel developer/sponsor to support both ASTM specification development and FAA certification policies, eliminating the need for redundant testing.

3) Establishment of a solicitation and selection process for candidate unleaded avgas for the centralized fuel testing program. This process should include a FAA review board with the technical expertise necessary to evaluate the feasibility of candidate fuels.

[2] The UAT ARC Final Report Part 1 and Part II are available at the following Web sites:

- http://www.faa.gov/regulations_policies/rulemaking/committees/documents/index.cfm/document/information/documentID/882
- http://www.faa.gov/regulations_policies/rulemaking/committees/documents/index.cfm/document/information/documentID/883

4) Establishment of a centralized certification office with sufficient resources to support unleaded aviation gasoline projects.

5) Establishment of a collaborative industry-government initiative referred to as the Piston Aviation Fuels Initiative (PAFI) to implement the UAT ARC recommendations to facilitate the development and deployment of an unleaded avgas with the least impact on the existing piston engine aircraft fleet. The overall objective of this initiative is to identify candidate unleaded aviation gasolines, to provide for the generation of qualification and certification data on those fuels, and to support certification approval of the most promising fuels.

The 14 additional UAT ARC recommendations are detailed in the report and support various components of the 5 key recommendations to transition to a replacement avgas.

5.0 The FAA Unleaded Avgas Transition Action Plan

The UAT ARC final report provided an integrated strategy for the FAA and industry to collaborate on the development, approval and deployment of an unleaded avgas. The FAA issued an Unleaded Avgas Transition Action Plan (UAT Action Plan) that details several options for implementation of the UAT ARC recommendations. These options range from the complete program recommended in the UAT ARC final report to reduced-scope efforts that retain key elements of the program recommendations requiring direct FAA involvement, but which would rely more heavily on direct support and action from aviation equipment manufacturers and candidate fuel producers. Appendix A contains an R&D plan that proposes a reduced scope of fuels evaluation focused on the transparent fleet (i.e., those aircraft that use the new fuels without undergoing any modifications) and eliminates the development of data and certification of modifications required for those unable to operate on these new fuels without modifications, i.e., the "non-transparent" fleet.

6.0 Certification Activities

The FAA accepts amended Type Certificate (TC) and Supplemental Type Certificate (STC) applications from applicants seeking approval of unleaded avgas for specific aircraft, engines, and aircraft/engine combinations. We are working with two STC applicants who are developing unleaded avgas alternatives. These activities are conducted independently of the Aviation Fuel R&D Program, and they are supported by the AIR staff under the FAA's operations budget.

7.0 Research and Development Plan

Section 910 of the FAA Modernization and Reform Act of 2012 required that the FAA develop an Aviation Fuel R&D plan within 120 days of the passage of the Act. The FAA completed an initial plan on June 13, 2012, by adjusting the goals of the "NextGen Alternative Fuels for General Aviation" project, while reflecting the existing funding framework. However, the FAA realized that this approach was inadequate, and therefore

submitted a 2014 budget request of $5.571 million to support the R&D requirements of the FAA UAT Action Plan. The technical aspects of the resulting R&D plan, reflecting this increased funding request and the associated expanded work scope are included in Appendix A.

Section 910 also specifies that the FAA, in coordination with the National Aeronautics and Space Administration (NASA), shall continue unleaded fuel research and development activities. The FAA's collaboration with NASA in aviation research over the years has yielded significant benefits to the safety of the civil aerospace system. Although NASA is not currently engaged in avgas research, the FAA will remain engaged with NASA regarding avgas research and will work to ensure that any efforts in this area are mutually supportive.

7.1 Initial Research and Development Activity

In Fiscal Year (FY) 2012, the FAA Technical Center initiated development of a standardized engine detonation test method, procured test engines and other necessary equipment to support unleaded fuel testing and initiated testing of unleaded fuels and aircraft modifications necessary to operate with candidate unleaded fuels. See Table 1 for a status of FAA research conducted in accordance with the initial efforts defined in compliance with Section 910 requirements.

Task	Research	Status	Deliverable
Flight 12-A	Detonation Method Development	Sea-level engine test cell evaluation completed. Test engine installed on flight test aircraft. Pre-flight checks and calibrations in process.	Internal R&D Report
Engine 12-A	Reduced lead detonation tests	CRC Task Group established to collaborate with industry. Several conference calls and meetings conducted. Test fuel blends selected and are now being formulated.	Internal R&D Report
Engine 12-B	Unleaded (UL) 94 engine detonation test	Engine build-up and instrumentation installation in process.	Internal R&D Report
Engine 12-C	Fleet Octane parametric assessment	Contractor selected and work in progress. Initial data has been developed, critical engines identified.	Internal R&D Report
Resources 12	Testing support resources	Evaluating responses to test cell fire suppression system bid request. Initiated purchase of mid-octane demand engines to evaluate UL94 performance. Developing equipment requirements to establish simulated altitude test capability.	As required

Status of FAA Research - Table 1

The FAA also successfully leveraged the work completed by the UAT ARC to address other unleaded avgas transition R&D requirements, including certification methods and processes, assessment of technologies to modify existing piston engine aircraft for operation on unleaded avgas, and development of recommendations for policies and guidelines to facilitate a transition to unleaded avgas for the piston engine aircraft fleet.

7.2 Upcoming Research

The scope of future FAA research will be based on the new aviation fuel R&D funding plan (see Appendix A). This research will be performed by the FAA to meet both the requirements of section 910 of the 2012 FAA Modernization and Reform Act and the recommendations of the UAT ARC. Both section 910(a) and the UAT ARC recommendations call for research and development activities to support qualification of an unleaded aviation fuel and safe transition of this fuel into the existing and future fleet of piston engine aircraft. The work scope reflects the recommended Technical & Evaluation (T&E) tasks of the UAT ARC final report. That report recommends a 3-stage program over an 11-year period that encompasses preparatory, project, and deployment stages. The preparatory and project stages align with the aviation fuel R&D program. The project stage T&E tasks described in the UAT ARC final report consist of Phase 1 and partial Phase 2 testing over a 5-year period. The FAA will perform Phase 1 fuel property testing of up to 10 candidate fuels, followed by Phase 2 engine and aircraft testing of the 2 best performing fuels from Phase 1. The data produced from this testing will support both ASTM qualification and FAA certification approvals of the candidate fuels. The FAA will establish facilities and equipment to support both Phase 1 and 2 testing.

This research will include the following:

- The development of qualification and certification methodologies to support certification of unleaded fuels with a range of octane values.
- The development of laboratory, rig, engine and aircraft test procedures to fully evaluate candidate unleaded avgas fuels.
- Laboratory and rig testing of candidate unleaded avgas fuels to evaluate the fuel properties and performance.
- Engine and aircraft performance, durability, operability, and detonation testing of candidate unleaded avgas fuels.
- The compatibility of non-metallic materials with new unleaded fuel formulations.
- The evaluation of candidate unleaded fuels across the full range of certified aircraft operating conditions.
- Investigation of high octane unleaded fuels emissions.
- Assessment of new propulsion technologies necessary to ensure safe operation on significantly reduced octane fuels in the legacy fleet. This may include testing of detonation suppression systems, advanced control systems or other mitigation systems, and the investigation of detonation measurement thresholds.
- Development of policies and/or guidelines to support certification of new unleaded fuels for large groups of engines and aircraft.

- Investigation of the octane demands of the current fleet and various means to bracket sub-populations to allow for approval of large groups of engines and aircraft.

8.0 Unleaded Avgas Transition Leadership

On August 12, 2012, the FAA established a Fuels Program Office reporting to the Director of AIR. The Fuels Program Office Manager will provide leadership for all AIR fuels activities including the Unleaded Aviation Gasoline Transition Program. This office is funded within the AIR's existing operations budget. This office incorporates the "centralized certification office" recommended by the UAT ARC to process all avgas related certification projects resulting from this program, and from other projects. This office will also support activities of the UAT Action Plan which are not funded by the R&D program (such as Certification and Qualification (C&Q) tasks).

9.0 Conclusion

The formidable combination of technical and economic barriers to developing a satisfactory and safe replacement unleaded fuel, combined with the challenge of recertifying the existing general aviation piston engine fleet, will require the expertise and support of the many diverse entities involved in aviation aircraft, engine and gasoline production, testing, distribution, sale, and use along with regulatory bodies such as the EPA and the FAA. The UAT Action Plan, reflecting the UAT ARC recommendations and using the FAA's historical fuel research, will be the roadmap to achieving our goal to have a replacement fuel for leaded aviation gasoline available by 2018 for most general aviation aircraft. The UAT Action Plan lays out options dependent on available funding for an R&D program for the qualification of and transition to an unleaded avgas. The UAT Action Plan provides for the development of certification procedures and acquisition of data necessary for certification, and the evaluation of modifications that may be necessary for safe operation of the "non-transparent" general aviation fleet, and will support the development of a transition plan to facilitate the transfer of the general aviation fleet to an unleaded avgas.

Section 910 Aviation Fuel Research and Development Program Report

Appendix A –Aviation Fuel R&D Plan

1.0 Introduction

This plan defines an expanded set of R&D tasks that reflect the new aviation fuel R&D funding request in the 2014 Budget. These tasks are to be performed by the FAA to meet both the requirements of section 910 of the 2012 FAA Modernization and Reform Act and the recommendations of the UAT ARC. Both section 910(a) and the UAT ARC recommendations call for research and development activities to support qualification of an unleaded aviation fuel and safe transition of this fuel into the existing and future fleet of piston engine aircraft. The scope of this effort is based upon the T&E tasks of the PAFI Medium plan described in the draft UAT Action Plan (see section 5.0), dated September 13, 2012.

The research and development activities for unleaded aviation fuel, as specified by section 910(b) of the 2012 FAA Modernization and Reform Act, require the Administrator to:

> "(1) not later than 120 days after the date of enactment of this Act, develop a research and development plan containing the specific research and development objectives, including consideration of aviation safety, technical feasibility, and other relevant factors, and the anticipated timetable for achieving the objectives;
> (2) assess the methods and processes by which the FAA and industry may expeditiously certify and approve new aircraft and recertify existing aircraft with respect to unleaded aviation fuel;
> (3) assess technologies that modify existing piston engine aircraft to enable safe operation of the aircraft using unleaded aviation fuel and determine the resources necessary to certify those technologies; and
> (4) develop recommendations for appropriate policies and guidelines to facilitate a transition to unleaded aviation fuel for piston engine aircraft."

The UAT ARC final report recommends a 3-stage program over an 11-year period that encompasses a preparatory, project, and deployment stages. The preparatory and project stages align with the aviation fuel R&D program. The project stage T&E tasks described in the PAFI Medium plan consist of Phase 1 and partial Phase 2 testing over a 5-year period. The FAA will perform Phase 1 fuel property testing of up to 10 candidate fuels, followed by Phase 2 engine and aircraft testing of the 2 best performing fuels from Phase 1. The data produced from this testing will support both ASTM qualification and FAA certification approvals of the candidate fuels. The FAA will establish facilities and equipment to support both Phase 1 and 2 testing.

The FAA implementation of the PAFI Medium plan will commence in FY 2014. This was preceded by the Transition Year (FY 2012) and the Prep Year (FY 2013). During the Transition Year, the FAA allocated minimum resources to support key start-up activities and decision making, such as funding a transition consultant and performing key UAT ARC T&E and C&Q tasks defined in the UAT ARC final report. The T&E

tasks were performed by the FAA Technical Center and were intended to address technical issues relating to the evaluation of unleaded aviation gasolines. The T&E tasks initiated during the transition year also met the section 910 R&D requirements.

During the Prep Year, the FAA will continue to perform some initial work tasks and coordinate with industry while determining the funding and resources to be applied to the UAT ARC recommendations in the years following FY 2013. The FAA will provide a PAFI Steering Group (PSG) co-lead and provide administrative support during the prep year. Similar to the Transition Year, the T&E tasks will be performed by the FAA Technical Center and are intended to address technical issues relating to the evaluation of unleaded aviation gasolines. The T&E tasks performed during the Prep Year will also meet the section 910 R&D requirements.

2.0 Prep Year (FY 2013)

During the Prep Year, the FAA Technical Center research will focus on developing key test methods that can be utilized to support future engine and aircraft testing of candidate unleaded fuels. Data and research to support the development of qualification and certification methodologies for those fuels will be provided. The full operating envelope and emissions of high octane fuels will be investigated. Data will be provided to industry stakeholders and certification officials on the legacy fleet safety effects related to deviation from the current specification and fit-for-purpose (FFP) fuel properties. The FAA Technical Center may also assess new technologies to ensure safe operation on significantly reduced octane fuels by the legacy fleet. A portion of the FY 2013 funding of $1.995 million will be utilized for these tasks.

Table A-1: Prep Year (FY 2013) Tasks

Task	Research	Outcome
T&E 4	Detonation Method Development	Develop test methods to correlate in-flight detonation testing with ground-based engine test cell testing
T&E 4	UL94 Engine Detonation Testing	Detonation test of limiting engine using UL94 to support ASTM Task Force on UL94 production spec approval and to support verification of Crown parametric model
T&E 4	Detonation Method Development	Comparison of industry and FAA Technical Center detonation measurement systems,
T&E 4	Detonation Method Development	Determine ambient effects (Inlet Air Temperature, Humidity, Pressure) on octane results
T&E 4	Emissions Testing	Establish capability to perform lead, NOx, CO, CO2, and THC emissions
T&E 5	Testing support resources	Test engines, test support equipment, instruments, contractor support to support above described testing

3.0 FY 2014

FY 2014 is the first year of the expanded work scope that reflects the Budget request for $5.571 million of funding. FY 2014 research will address Phase 1 and 2 recommended research tasks from the Preparatory Stage of the UAT ARC final report, dated February 17, 2012. The research will establish test facilities to perform Phase 1 and 2 tests on candidate fuels and develop standardized FFP properties test methods and procedures. These will consist of current ASTM D910 specification laboratory test methods, and newly developed specific fuel-related laboratory tests, material compatibility, toxicology, and rig tests. FY 2014 research will also continue to develop Phase 2 standardized engine and aircraft test methods for candidate test fuels.

Table A-2: FY 2014 Tasks

Task	Research	Outcome
T&E 1	Develop standardized FFP test procedures	These procedures will support the evaluation of an expanded set of fuel properties necessary to determine the performance of candidate fuels. This testing may address issues related to cold fuel flowability, flame speed, heat of combustion, fuel nozzle spray patterns, fuel/oil interaction, co-mingling with current fuels, and lubricity. Novel fuels with unique properties may require additional FFP test procedures. The test results will be compared to the corresponding data for the currently approved ASTM D910 100LL fuels.
T&E 1	Develop standardized rig testing procedures	These will be used to measure and quantify FFP properties for candidate fuels.
T&E 1	Develop standardized material compatibility test procedures	These will be used for testing of key airplane and engine fuel system elastomers, seals and other non-metallic parts to measure property changes such as percent volume change, hardness, tensile strength, etc. for candidate fuel.
T&E 1	Develop standardized toxicology test procedures	These will be used for the evaluation of toxicological effects of proposed novel candidate fuels
T&E 4	Detonation Method Development	Continue development of detonation test methods for unleaded fuels.
T&E 2 & 5	Testing support resources	Test engines, test support equipment, instruments, contractor support to support above described testing

4.0 FY 2015

FY 2015 research will address Phase 1 and 2 recommended research tasks from the Preparatory and Project Stages of the UAT ARC final report. Phase 1 fuel properties testing will be performed in FY 2015 and the establishment of Phase 2 test facilities and standardized engine and aircraft test methods will continue.

Table A-3: FY 2015 Tasks

Task	Research	Outcome
T&E 3	Develop Phase 1 report guidelines	This will define data requirements necessary to support ASTM and FAA approval requirements.
T&E 7	Conduct Phase 1 testing.	FFP property testing of candidate fuels that will include fuel performance, materials compatibility, and toxicological testing.
T&E 8	Prepare Phase 1 Test Reports	Provide data reports for those candidate fuels that have completed testing to support ASTM and FAA approval requirements.
T&E 4	Phase 2 Test Method Development	Continue development of Phase 2 test methods including detonation test methods for unleaded fuels.
T&E 5	Testing support resources	Test engines, test support equipment, instruments, contractor support to support above described testing

5.0 FY 2016

FY 2016 research will address Phase 1 and 2 recommended research tasks from the Preparatory and Project Stages of the UAT ARC final report. Phase 2 engine and aircraft testing will be performed in FY 2016 and the Phase 2 test facilities will be maintained as required.

Table A-4: FY 2016 Tasks

Task	Research	Outcome
T&E 6	Develop Phase 2 report guidelines	This will define data requirements necessary to support ASTM and FAA approval requirements.
T&E 8	Prepare Phase 1 Test Reports	Provide data reports for those candidate fuels that have completed testing to support ASTM and FAA approval requirements.
T&E 9	Conduct Phase 2 testing.	Engine and aircraft testing of up to two candidate fuels that will include performance, durability, and operability.
T&E 5	Testing support resources	Test engines, test support equipment, instruments, contractor support to support above described testing

6.0 FY 2017

FY2017 research will address Phase 2 recommended research tasks from the Project Stage of the UAT ARC final report. Phase 2 engine and aircraft testing will be performed in FY 2017 and the Phase 2 test facilities will be maintained as required.

Table A-5: FY 2017 Tasks

Task	Research	Outcome
T&E 9	Conduct Phase 2 testing.	Engine and aircraft testing of up to two candidate fuels that will include performance, durability, and operability.
T&E 5	Testing support resources	Test engines, test support equipment, instruments, contractor support to support above described testing

7.0 FY 2018

FY 2018 research will address Phase 2 recommended research tasks from the Project Stage of the UAT ARC final report. Phase 2 engine and aircraft testing will be performed in FY 2018, Phase 2 test facilities will be maintained as required, and Phase 2 reports will be prepared.

Table A-6: FY 2018 Tasks

Task	Research	Outcome
T&E 9	Conduct Phase 2 testing.	Engine and aircraft testing of up to two candidate fuels that will include performance, durability, and operability.
T&E 10	Prepare Phase 2 Test Reports	Provide data reports for those candidate fuels that have completed testing to support ASTM and FAA approval requirements.
T&E 5	Testing support resources	Test engines, test support equipment, instruments, contractor support to support above described testing