Project 034(A) National Jet Fuel Combustion Program – Area #7 Overall Program Integration and Analysis

University of Dayton

Project Lead Investigator

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University Participants

University of Dayton

- P.I.(s): Joshua Heyne, Assistant Professor
- FAA Award Number: 13-C-AJFR-UD-004
- Period of Performance: February, 20, 2015 to January 28, 2016
- Task(s):
    1. Integration of Efforts from all NJFCP members.
    2. Dissemination of Information including but not limited to
    3. Analyze Data and Computational Results
    4. Recommend Future Research Directions

University of Illinois – Urbana Champaign

- P.I.(s): Tonghun Lee, Associate Professor
- FAA Award Number: 13-C-AJFE-UI-006
- Period of Performance: 12/16/2014 to 11/30/2015
    5. Compilation of test data and review of laser diagnostics plan

Project Funding Level

The FAA has provided funds of $85,000 and $15,000 for the University of Dayton and University of Illinois respectively. Cost share for the University of Dayton has been provided by the University of Dayton Mechanical Engineering Department in the form of salary and benefits for Dr. Heyne and NRC-Canada in the form of in-kind research on sprays and altitude relight tests. Cost share from the University of Illinois has come from In-kind academic time of the PI and partial support for student Research Assistantship.

Investigation Team

List the investigation team and specify the tasks for which they are responsible, their role in the team, and university affiliation. Include graduate students and post-doctoral researchers.

- Joshua Heyne (University of Dayton) –Overall Program Integration and Analysis
    - Tasks:
        - Integration of Efforts
        - Dissemination of Information
        - Analyze Data and Computational Results
        - Recommend Future Research Directions
- Steven Zabarnick (UDRI) – Fuel properties/composition and chemical kinetics
- Scott Stouffer (UDRI) – Fundamental and applied combustion and sprays

- Matthew DeWitt (UDRI) – Fuels properties and combustion emissions
- Alex Briones (UDRI) – Applied combustion modeling and simulation
- Tonghun Lee (University of Illinois) – Fundamental combustion, optical diagnostics, and data base coordination
    - Task(s):
        - Compilation of test data and review of laser diagnostics plan

Project Overview

Area 7, ASCENT Project 34, of the NJFCP is responsible for the overall integration and analysis of the program. Our role in the program is nominally the completion of the annual success criteria of the NJFCP. The execution of the role leads Area 7 to be involved in both high level and detailed ongoing within the program. Area 7 contributes to high level discussions with the Steering Committee, OEM members, and contributors on a daily basis. These high level contributions consist of but are not limited to long term strategic goals of the NJFCP, annual success criteria of the program, the involvement of additional and existing strategic partners, and general programmatic directions. Additionally, Area 7 makes detailed contributions to individual tasks of funded Areas regularly through monthly discussions with the three major program Working Groups (the Testing, Modeling, and Steering Committee), the various sub-committee meetings, and the annual success criteria of the program via planning.

- **Task: Integration of Efforts**
    - University of Dayton
- **Task: Dissemination of Information**
    - University of Dayton
- **Task: Analyze Data and Computational Results**
    - University of Dayton
- **Task: Recommend Future Research Directions**
    - University of Dayton
- **Task: Compilation of test data and review of laser diagnostics plan**
    - University of Illinois

Objective(s)

The objective of this Project is to facilitate the accomplishment of the annual success criteria through overall program coordination and integration towards the streamlining of the certification process of alternative jet fuels.

Research Approach

The objective of this project is completed through the regular interaction of this team with the other member institutions of the NJFCP. These interactions involve both high level programmatic discussions with the Steering Committee and the engine OEMs and detailed discussions with the various experimental and modeling activities within the program. These interactions are completed through regular contact in the form of monthly meeting, impromptu teleconferences, emails, and phone calls with NJFCP stakeholders. These stakeholders include, but are not limited to, the 7 funded academic Areas within the NJFCP, NRC Canada, AFRL, FAA, ARL, NIST, University of Sheffield, DLR Germany, NASA, the 5 OEMs, AFOSR, and the involved universities under AFOSR funding. The tasks of this project were completed in conjunction with these partners in the following manner:

- Integration of Efforts: As mentioned above, Project 34 organized and executed meetings with the three NJFCP working groups, the various sub-committees, daily phone calls with the Steering Committee, phone calls with partners/members, and emails to ensure efforts and activities were properly integrated. Teams' efforts were integrated not only through discussions with Project 34 but also within the various members present on calls, email threads, and meetings. Due to these integration activities greater program alignment communication shortcomings were avoided and success criteria obtained.
- Dissemination of Information: Project 34 worked to circulate and disseminate information critical to program success. Both technical and programmatic information was sent to effete areas. Technical information such as experimental conditions, strategic needs, and latest results from each member were circulated to relevant parties. Programmatic information regarding future meetings, future research directions, and other programmatic maters were communicated to the NJFCP members as needed.

- Analyze Data and Computational Results: Results from NJFCP members were analyzed at the three monthly NJFCP working groups, the routine sub-committee meeting, and through regular interactions with members (e.g. phone calls and emails). The both computational and experimental results were scrutinized by Project 34. These analysis lead to tighter integrations by closing scientific gaps between the various Areas.
- Recommend Future Research Directions: Project 34 recommended future research directions through regular high level interactions with the NJFCP Steering Committee. These interactions lead to the current plans for delivery of NJFCP computational techniques to the OEM community and the standardization of the referee rig. These plans, if properly executed, would mark the pinnacle of achievement for the NJFCP, i.e. the delivery of a tool to streamline the certification process of alternative jet fuels.

Milestone(s)

- NJFCP Mid-Year Meeting

Major Accomplishments

- Facilitating the successful completion of success criteria 1 and 3. Success criteria 2 completion, as of 29 September 2015, is in progress and is anticipated to be completed by the first year of the program.
- Planning and facilitating the two NJFCP review meetings.
- Presenting on behalf of the NJFCP at the CRC Aviation Fuels Meeting in Nashville, TN in May.

Publications

1. J. S. Heyne, F. L. Dryer, S. H. Won, F. M. Haas, "Reactivity Comparisons of Conventional and Alternative Jet Fuels in a Variable Pressure Flow Reactor," 9th US National Combustion Meeting, 2015, Cincinnati, OH.
2. M. Colket, J. S. Heyne, M. Rumizen, J. T. Edwards, M. Gupta, W. M. Roquemore, J. P. Moder, J. M. Tishkoff, C. Li, et al., "An Overview of the National Jet Fuels Combustion Program," Accepted for presentation at AIAA SciTech Meeting, San Diego, 2016.

Outreach Efforts

1. J. S. Heyne, M. Colket, "National Jet Fuels Combustion Program: Overall Program Integration and Analysis," CRC Aviation Committee Meetings, Nashville, TN, 6 May 2015.
   Presentation on behalf of the NJFCP to the fuels community.

Awards

None.

Student Involvement

None.

Plans for Next Period

The assembled team will continue to execute the aforementioned goals and objectives consistent with the past year's approach. This will involve the continued close interaction with university research teams, engine manufacturers, contractors, federal government researchers, and allied partners to perform comparative analyses of results, organize meetings, align efforts, and aid the Steering Committee. Fundamentally, the Area #7 team will serve at the behest of the Steering Committee to facilitate attainment of the overall goals of the NJFCP program and the needs of the OEMs to enable program directives, provide leadership, optimize strategic partnerships, and provide accountability.

The program directives, e.g. annual success criteria and streamlining new aviation fuel certification via ASTM D4054, will be the central focus of this project. We will align individual research efforts within the program and use these directives holistically in decision making processes. Further, these directives will be continually communicated to NJFCP members. Our team will provide leadership to the NJFCP. As the central point of contact and singular consistency across communications, we will communicate clearly and concisely the role of each program member ensuring program cohesion and efficiency. We will continue to implement program strategy into program efforts.

The strategic partnerships of the various allied partners (e.g. DLR Germany, NRC Canada, the University of Sheffield, ARL, AFRL, NASA, Navair, NIST, AFOSR, DOE laboratories, engine OEMs) will be optimized. We will work to leverage the experience and capabilities of existing and emerging allied partners. This will include but is not limited to the concerted spray efforts at NRC Canada and Area 5, the complementary combustor rig testing at NASA Glenn, and the comparative fuels study at DLR Germany. We look to continue to develop burgeoning partnerships such as the University of Sheffield. We will provide accountability to the program by giving visibility to missed tasks, milestones, incomplete and inconsistent data, unphysical models, and etc. The team will keep up-to-date on the progress of the six individual projects and allied partners, working with teams to provide program status reports and monitor archival progress. This will include providing monthly telecom meeting on the overall and incremental program progress and outcomes. Additionally, this team will be involved in biweekly teleconferences with the Steering Committee. Further, the team will work closely with the funded teams to assure that the program schedule is being met. Deviations from schedules and program progress will be noted and subsequent adjustments made to project schedules. Comparative data analyses of modeled and measured results will involve analyzing the sufficiency and credibility of individual research area results and their interfacing. These analysis tasks will require a wide breadth of combustion and fuels research experience as exemplified by our proposed team composition. Data from experiments must sufficiently constrain modeling predictions. Correspondingly, modeling predictions need to be performed over equivalent parameter spaces to check for model fidelity. Key modeling parameters, such as rate constants in chemical kinetics, will be checked over a wide range of operational conditions to ensure predictive fidelity. Furthermore, experimental data must be reported with the appropriate experimental uncertainties.