

## Project 033(B) Alternative Fuels Test Database Library

### University of Illinois at Urbana-Champaign

#### Project Lead Investigator

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#### University Participants

##### University of Illinois at Urbana-Champaign

- P.I.(s): Tonghun Lee, Associate Professor
- FAA Award Number: 11812030
- Period of Performance: 2/19/2015 to 8/14/2016
- Task(s):
  1. Development of an alternative fuels test database

#### Project Funding Level

Funding Level: \$133K

Cost Share: In-kind academic time of the PI, Software license support from Reaction Design (ANSYS)

#### Investigation Team

- Kyungwook Min (Graduate Student, University of Illinois at Urbana-Champaign): Compilation of fuel test data.
- Anna Oldani (Graduate Student, University of Illinois at Urbana-Champaign): Compilation of fuel test data and development of database.

#### Project Overview

This study aims to establish a foundational database of current and newly emerging alternative jet fuels by integrating all pre-existing jet fuel relevant data into a common archive which can provide guidelines for design and certification of new jet fuels in our future as well as steer federal policy. In the near term, the effort will focus on integration and analysis of pre-existing jet fuel data from various government agencies and individual research groups with oversight from both the Federal Aviation Administration (FAA) and the National Institute of Standards and Technology (NIST). In the long run, we hope that the database will act as ‘the comprehensive and centralized knowledgebase’ shared by the academic, government, and industrial communities in fuels research and policy, possibly facilitated on a cyber-based infrastructure. With prolific diversification of new jet fuels in our future, an effort to integrate dispersed information would be critical in providing the FAA with an overview of the latest developments and to support many other tangential fields of research impacted by integration of new alternative jet fuels.

#### Task 1 – Development of an Alternative Fuels Test Database

University of Illinois at Urbana-Champaign

##### Objective(s)

The main objective of this study is to establish a *foundational database* of current and newly emerging alternative jet fuels by integrating all pre-existing jet fuel relevant data into a common archive which can provide guidelines for design and

certification of new jet fuels in our future as well as steer federal policy. This proposal outlines the year II efforts under this mandate. The vision is to institute a database that can be utilized for the design and optimization of new propulsion and energy systems including development of next-generation engines, fuel delivery systems, as well as pollution mitigation technologies. Furthermore, it can provide data for screening and certification of newly emerging fuels and thereby impacting legislative measures and national policy. In so doing, the goals of this project are as follows:

- Survey current pre-existing data and analyze information
- Prioritize current data and compile into centralized logical structure
- Analyze the obtained information into chronological order and regroup into relevant group
- Obtain information on detailed test platform and test conditions
- Develop a controlled web portal for access to the information
- Develop and implement a database/web portal infrastructure and methodology
- Integrate data from FAA ASCENT National Jet Fuel Combustion Program (NJFCP)

## Research Approach

### **Development Strategy of a Successful Fuels Test Database**

- **Phase I: Integrate Current Pre-Existing Data:** Preliminary survey and integration of all pre-existing database and data (including raw data) on jet fuels from universities, national laboratories, government archives, and private industry (i.e., existing database from Sandia, NIST, DoD Labs, ASTM research reports, government technical reports etc. is part of the year I efforts and will be used to initially seed the basic infrastructure of the fuels database proposed in this study. Year II efforts will continue to assemble information and annex a prioritized set into the web portal/database. In year II, we anticipate a more focused effort in integrating fuel property test data from certification protocols.
- **Phase II: Analysis of Preliminary Data:** Conduct comprehensive analysis of the initial data to categorize all relevant physical and chemical characteristics of the fuels and relevant testing conditions. Effort will be made to determine insufficient areas for further investigation. In year II, we will significantly expand our efforts to the analysis of information into chronological order and in incorporating detailed test platform and test condition data. An effort will be made to re-categorize the data according to different testing groups and performance. A preliminary effort will be made to vet some of the data according to test conditions as required (future efforts will more fully address vetting and analysis of data)
- **Phase III: Establish Web Portal/Database Infrastructure and Methodology:** A basic web portal will be established during the year I efforts. In year II, based on the analysis of pre-existing data, we will work with NIST and other national laboratories to establish a flexible and accessible database structure and data access protocols for both retrieval of current data and integration of new information in the future. This will be integrated into the web portal. We anticipate increased functionality in the web portal to conduct advanced searches and user feedback on each data item (community based vetting system).
- **Phase III-b: Integration of FAA ASCENT and NJFCP Data:** New data generated from both the FAA ASCENT and the NJFCP will be integrated into the database according to the pre-defined infrastructure. This will be coordinated with Area #7 of the NJFCP program.
- **Phase IV: Integrate with Current and Future Research:** Disseminate and integrate new database to relevant research groups in universities, national laboratories, government, and industry. Formulate partnerships for stewardship, preservation, and continued development of the alternative jet fuel database.
- **Phase V: Continued Development:** Continue development of the database after the initial integration and distribution phase into a more widely distributed community based infrastructure (potentially cyber-based). Link and expand the database to encompass pre-existing data from other countries.

### Milestone(s)

These are the milestones according to each time period.

**Proposed (3 Month):** At the 3 month mark, we will have concluded an exhaustive survey to obtain all fuel relevant data from individual PIs and national laboratories. We will work with the advisory committee and other PIs in the NJFCP and ASCENT to ensure that a comprehensive and complete survey of data has been completed. During this time, we will initiate efforts to start the physical construction of a database and work with web designers and relevant personnel for deployment. Data format for the FAA ASCENT and NJFCP research will also be acquired during this time.

**Achieved:** Basic survey of the fuels test data has been accomplished and a plan is in place for construction of a web based database. We have discussed the format of a metafile to deal with the data. We have a list of data formats that will become

available in the database.

**Proposed (6 Month):** At the 6 month mark, we should have a preliminary version of a standardized platform with integration of data from all federal, academic, and industrial sources. The focus will be on smooth and logical integration of data, and clear organization of information into subgroups.

**Achieved:** A preliminary outline of a web-based portal is in place and we have started to analyze the data for integration into the database. The NJFCP has also contributed two quarters of data to be integrated in to the database. We have visited AFRL to discuss how to extract data at AFRL for integration into the database.

### Major Accomplishments

The newly established alternative jet fuels database website is shown in Figure 1 ([altjetfuels.web.engr.illinois.edu](http://altjetfuels.web.engr.illinois.edu)).



**Figure 1** Alternative Jet Fuel Test Database site homepage

During the past year, several tasks were completed with regard to development of the Alternative Jet Fuels Test Database. The site to house the database was established through the coordinated efforts of members of the University of Illinois team and Engineering IT services at the University of Illinois. A screenshot of the homepage of the site is shown in Figure 1, displaying the main feature of the site. These features include a general *About* section with information regarding the mission and goals of the database project, funding agencies of the program, a directory of members involved in the work, and links to partner institutions participating in the larger FAA ASCENT database project. Users have two methods to access data made available on the site. The first is a search feature where users can input search terms of interest including authors, title, DOI, year of publication, data type, and keywords. The second feature is a grouping of data by subject area; users can then follow through the sublevel categories to access specific data grouped under various topic areas. Figure 2 displays a sampling of the current data categorization. The site will also house data from the National Jet Fuel Combustion Program (NJFCP) Areas 1 through 6. To access any data (in the *Search*, *Database*, and *NJFCP* menu

headings), users will first be required to request access, and once the request for access has been approved by site administrators, the user can then register a username and password to login on the site and search through the database. Registered users will also be able to submit data directly to the site. These submissions will be received by the site administrators and posted once the proper classification has been assigned to the data. The site will display general information available to the public only in the *About* and *News* headings. The *News* section highlights recent activity related to the various projects underway in the program and general activity in the alternative jet fuels field. Finally, users will be able to leave comments under the *Contact* section, which will direct all submissions to site administrators. The general sections of the site have been completed and testing of the search features for sample data submissions is currently underway. Data has been received from AFRL and NJFCP program areas with discussions for further data to be obtained from the AFRL fuel database system. Data will be continuously uploaded and updated on the site as it is received, with registered users able to submit comments on all available data.

Data Type	Examples	Sample File Types
Chemical Kinetics Data	Mechanisms	.TXT, CHEMKIN
Testing Results	Shock Tube, Rapid Compression Machine, GC MS	EXCEL, .CSV
Fuel Properties	Lab Analysis Reports	EXCEL, .CSV, PDF
Publications	Production Processes, Reaction Studies, Chemical Kinetics, Economic Analyses, Technical Reports, Fuel Certifications	PDF

Figure 2 Sample data categories

### Publications

None

### Outreach Efforts

None

### Awards

None

### Student Involvement

Two graduate students (listed above) have participated in this project on a rotational basis to address various aspects of the project. Their main tasks have been to survey the data, interact with the data source and come up with a strategy to integrate the data into the database. They have also been working to develop the web-based portal for the actual implementation of the web interface.

### Plans for Next Period

In year II of the NJFCP, we plan to expand the efforts and integrate as much data as possible into the database. The format of the database should be fully in place and the main challenge is expected to come from dealing with the many different format of data. Eventually, we anticipate three areas that the project should move into. (1) Organization of data that is most relevant to the community, (2) Analysis of the data and statistical analysis, and (3) Development of database into a cyber-based infrastructure.