Introduction

This document provides candidate alternative fuel producers with procedures for engaging with the D4054 Clearinghouse to conduct evaluations of their prospective alternative fuels in accordance with ASTM D4054 “Standard Practice for Qualification and Approval of New Aviation Turbine Fuels and Fuel Additives.” The D4054 standard practice provides a framework for the qualification of new fuels and additives for use in commercial aviation gas turbine engines. The D4054 process and this procedure are intended to facilitate incorporation of the candidate alternative fuel into ASTM D7566 “Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons.” ASTM D7566 consists of annexes which define physical and chemical property requirements of individual alternative fuel types. Fuels meeting the D7566 specification can be reidentified as Jet A fuel meeting ASTM D1655 “Standard Specification for Aviation Turbine Fuels” and enter the fungible fuel distribution system as conventional fuels. Those alternative jet fuels that do not meet the criteria specified in any of the current annexes of D7566 are considered candidate alternative fuels. A candidate alternative jet fuel must be found to be fit for purpose for use in gas turbine engines and aircraft by the OEMs that design and produce those products before it can be incorporated into D7566 as a new annex. This fit for purpose determination is based on the data and information generated during the D4054 evaluation process.

The D4054 process is graphically depicted in Figure 1. It is a two phase process that relies on OEM and FAA review of test data after each phase for determination of the fit for purpose (FFP) of the candidate alternative jet fuel.

Figure 1
D4054 Qualification Process
Because of the iterative nature of the D4054 process, where OEMs provide feedback to fuel producers at each stage of the evaluation, a framework was established to guide and monitor each step in this iterative review process with the OEMs (see Figure 2). This framework is called the OEM Review Process. The D4054 Clearinghouse was established to guide candidate fuel producers through this OEM Review Process.

![Figure 2 - OEM Approval Process](image)

**Background**

The Federal Aviation Administration (FAA) established the D4054 Clearinghouse under its Center of Excellence for Alternative Jet Fuels and Environment (ASCENT) program. ASCENT is a cost-sharing program that the FAA established with academia and industry to conduct research on alternative jet fuels and the environmental impact of aviation. This type of program requires that the ASCENT participants at least match the level of funding contributed by the FAA for each specific project.

The D4054 Clearinghouse project is being managed by the University of Dayton Research Institute (UDRI). The FAA has provided a level of funding intended to establish the clearinghouse and support a limited amount of fuel testing and review. It is anticipated that other sources of funding or in-kind resources will be required from industry, academia, or other Government agencies to fully support the complete scope of testing for future candidate alternative jet fuel projects.
The cost for Phase 1 of D4054, which consists of Tier 1 and 2 testing is estimated to be $300,000 to $400,000 and will require approximately 100 gallons of fuel. Please note that this estimate includes only the fuel testing costs and OEM review costs, and does NOT include the cost to make the fuel and overhead costs of the fuel producer. The bulk of the Phase 1 costs are the OEM review costs which are driven by the engineering resources that the OEMs must allocate to conduct the review.

The costs for Phase 2 of D4054, which consists of Tier 3 and 4 testing (as required), can vary widely. This cost will depend on the results from the Phase 1 testing, the composition of the candidate fuel, and any other details that will influence the projected risk. Consequently, the cost of Tier 3 and/or Tier 4 testing it is estimated to be in the range of $3,000,000 to $5,000,000 and require from 30,000 gallons to 200,000 gallons of fuel. As with Phase 1, this does not include the cost to produce the fuel or overhead costs and a significant portion of the cost is for OEM review of the D4054 data.

Expect the entire D4054 process and subsequent ASTM balloting to take from 2 to 5 years, again, depending on the fuel composition, testing results, and projected risk of the candidate fuel.

The ultimate product of the aforementioned process and associated costs is a new annex in ASTM D7566 that enables the production and use of a specific alternative jet fuel pathway. The definition of a production pathway typically includes feedstock type, conversion process, and fuel composition and other attributes, but is not limited to any specific company. It’s important to note that after issuance of the annex in ASTM D7566, it is considered a commodity-type product similar to conventional jet fuel, and just like conventional jet fuel, any fuel manufacturer can produce the fuel in accordance with the criteria and requirements defined in the annex.

The level of funding, the quantity of test fuel, and other resources required to successfully complete the D4054 evaluation process are variable and will depend on the compositional characteristics of the proposed alternative fuel along with the cumulative test results as the evaluation progresses. However, as discussed above, the scope of the clearinghouse’s involvement and its ability to support the entire process will depend on the level of funding contributed by the FAA, the candidate alternative fuel producer, other Government agencies, and other aviation industry sources.

**Stakeholder Coordination and Engagement**

**ASTM Aviation Fuel Subcommittee:** As described above, the clearinghouse purpose and tasks are integral to the ASTM specification development process. The clearinghouse therefore will participate in all ASTM activities related to alternative jet fuel specification development such as task force, subcommittee and committee meetings, and coordinate with ASTM staff where necessary to advance a specific pathway through the D4054 process.

**Military:** The clearinghouse will establish a direct line of communication to Military organizations that are actively testing, evaluating, or approving alternative jet fuels to solicit testing recommendations and advice and to coordinate testing. The clearinghouse will make
every effort to avoid duplicative testing by sharing all test data with the military organizations, and will incorporate any military test data made available into the ASTM research reports.

**UK MOD Aviation Fuel Committee:** The clearinghouse will coordinate with the AFC and make available any data necessary to support incorporation of the specific pathway into DEF STAN 91-91. The clearinghouse will provide updates of D4054 qualification projects at the annual AFC meeting, or other meetings if necessary.

**Other Aviation Fuel Standards Development Organizations (SDOs):** There are numerous aviation fuel SDOs across the globe that are engaged in the development of specifications, or standards, for alternative jet fuel. The clearinghouse will coordinate with these SDOs as required to support the global introduction of alternative fuels.

**Airlines and Other User Groups:** The clearinghouse will coordinate with the alternative jet fuel user community regarding pathway status and schedule, testing priorities, and financial/resource support. The clearinghouse will provide status updates and other information at industry conferences such as the International Air Transport Association (IATA), the International Civil Aviation Organization (ICAO), or other user community events as necessary.

**Industry Technical Organizations:** The clearinghouse will participate in conferences, meetings, symposiums organized by industry technical organizations involved in aviation fuels such as the Coordinating Research Council (CRC), or the International Association of Stability and Handling of Fuels (IASH), or others, as appropriate or necessary to support the introduction of alternative jet fuels.

**Engine and Aircraft Manufacturers (OEMs):** The clearinghouse will establish direct contractual agreements with each OEM (where possible) to accommodate review of test data, or to conduct testing, as required. The clearinghouse will also maintain informal communications with all OEMs on a regular basis to ensure progress through the D4054 process.

**Steering Committee:** (Under Consideration) The clearinghouse will establish a steering committee comprised of representatives from the user community (airlines, IATA, A4A, NBAA, GAMA, etc), the military (USN, USAF, US Army) and the FAA to provide information and solicit guidance and feedback regarding pathway status and schedule, testing priorities, and financial/resource support. The steering committee will meet on a regular basis to review this information and to provide recommendations for on-going and future projects.

**Process Guide**

The procedure utilized by the Clearinghouse to advance candidate alternative jet fuels through the D4054 process will be structured around the OEM Review Process shown in Figure 2. The Clearinghouse will manage the testing and data review in six stages that encompass the nine steps of the OEM review process (see Figure 3).

This document details the procedures for each of the stages shown in Figure 3. It includes a description of the roles and responsibilities of the participants, the key process milestones, and communication and reporting requirements.
Figure 3
The D4054 Clearinghouse Process
Stage 1: Fuel Screening

Overview
The candidate fuel producer provides D1655 Table 1 test data for fuel produced using the specific process intended for approval, along with other information on the process and company. The data is reviewed by the D4054 Clearinghouse and guidance and advice is provided regarding readiness to start the clearinghouse process. If and when the clearinghouse determines that the producer is ready to enter the D4054 evaluation process, then the producer is requested to provide 100 gallons of neat test fuel for Tier 1 and 2 testing.

Producer Roles & Responsibilities
1. Submit an overview of the candidate fuel production process, including feed stocks and key process steps. Also include an overview of the company’s plans for commercialization and production scale-up. Specify the quantity of fuel that has been produced at time of submittal using the candidate process.
2. Submit data showing results of testing the candidate fuel to ASTM D1655, Table 1.
3. Identify and provide contact information for primary and backup project focal points.
4. Provide schedule for delivery of 100 gallons of neat test fuel.

D4054 Clearinghouse Roles & Responsibilities
1. Review the submitted information and data.
2. Provide feedback to the candidate producer regarding readiness for entry into the D4054 evaluation process.
3. Provide responses to any questions that the producer may have.
4. If the producer is ready to enter the process, then provide instructions on delivery of 100 gallons of test fuel for Tier 1 and 2 testing.

Logistics
1. Producer should submit report and data to:
   Dr. Steven Zabarnick
   University of Dayton Research Institute
   300 College Park
   Dayton, OH 45469-0043
   Steven.Zabarnick@udri.udayton.edu
   (937) 255-3549
Stage 2: Phase 1 Testing and Research Report
(Steps 1 & 2 of OEM Review Process)

Overview
The candidate fuel producer delivers 100 gallons of neat fuel produced using the specific process intended for approval to the D4054 Clearinghouse. The D4054 Clearinghouse either conducts Tier 1 and 2 testing in-house, or arranges with 3rd party test facilities to conduct testing. The test data is reviewed by the D4054 Clearinghouse and compiled into a draft Phase 1 Research Report that is submitted to the producer for review and further editing. The final Phase 1 Research Report is submitted by the D4054 Clearinghouse to the OEM review panel for review. The producer forms an ASTM Task Force with an associated ASTM work number.

Producer Roles & Responsibilities
1. Deliver 100 gallons of neat fuel produced using the specific process intended for approval.
2. Provide specific information on the test batch of fuel relative to the process and feed stock, and any other pertinent information.
3. Support review of Tier 1 and 2 data as requested.
4. Support writing of the Phase 1 Research Report as requested.
5. Update and consult with ASTM Task Force on regular basis.

D4054 Clearinghouse Roles & Responsibilities
1. Conduct in-house Tier 1 and 2 testing.
2. Arrange for 3rd party Tier 1 and 2 testing as required, and oversee test laboratories as required.
3. Compile Tier 1 and 2 test data.
4. Draft Phase 1 ASTM Research Report and coordinate review and editing with the producer.
5. Deliver final Phase 1 ASTM Research Report to OEM Review Panel.

Logistics
1. Producer should deliver in two 55 gallon epoxy-lined sealed drums fuel to:
   Mr. Sam Tanner
   University of Dayton Research Institute
   1790 Loop Rd North
   Wright-Patterson AFB, OH 45433
   (937) 713-0015 (office)
   (937) 416-4762 (cell)
Stage 3: Phase 1 OEM Review Process
(Steps 3 & 4 of OEM Review Process)

Overview
The D4054 Clearinghouse submits the Phase 1 research report to the OEM Review Panel for review and oversees the review process. The clearinghouse coordinates with the producer to respond to any questions from the OEM Review Panel during the review process. The D4054 Clearinghouse coordinates with the OEMs to consolidate additional Phase 1 test and/or data requirements for submittal to the producer. The D4054 Clearinghouse conducts additional Phase 1 testing and provides supplemental Phase 1 reports as required. The D4054 Clearinghouse engages with OEM Review Team to reach final consensus regarding advancement to Phase 2 testing. Upon OEM consensus for advancement, the D4054 Clearinghouse compiles and consolidates Tier 3 and 4 (Phase 2) test requirements and submits to the producer.

Producer Roles & Responsibilities
1. Support responses to OEM questions on Phase 1 Research Report.
2. Support additional Phase 1 testing or data generation as requested.
3. Update and consult with ASTM Task Force on regular basis.
4. Support generation of supplemental Phase 1 test/data reports as requested.

D4054 Clearinghouse Roles & Responsibilities
1. Submit Phase 1 Research Report to the OEM Review Panel.
2. Establish schedule for report review and organize periodic meetings with OEMs to review status and discuss the test results.
3. Communicate questions and responses between the OEMs and producer.
4. Conduct additional in-house Tier 1 and 2 testing as required.
5. Arrange for additional 3rd party Tier 1 and 2 testing as required, and oversee test laboratories as required.
6. Compile additional Tier 1 and 2 test data as required.
7. Draft supplemental Phase 1 reports as required and coordinate review and editing with the producer.
8. Deliver final supplemental Phase 1 reports to OEM Review Panel or hold for incorporation into final Phase 2 Research Report.
9. Engage with OEM Review Panel to support data review deliberations regarding the advancement of the proposed process to Phase 2 testing.
10. Compile and consolidate Tier 3 and 4 test requirements from OEM Review Panel and submit to producer.
Stage 4: Phase 2 Testing and Research Report
(Steps 5 & 6 of OEM Review Process)

Overview
The D4054 Clearinghouse coordinates with the OEMs and other 3rd party test facilities to determine test fuel quantity requirements, tests facility options, and test schedule and communicates these requirements to the producer. The producer establishes the necessary production capability to produce the required quantity of test fuel to meet the test schedule. The D4054 Clearinghouse works with the producer, OEMs, and other 3rd parties to determine funding requirements and potential funding sources. The clearinghouse then arranges contracts with the test facilities to conduct the Phase 2 testing. The test data is reviewed by the D4054 Clearinghouse and compiled into a draft Phase 2 Research Report that is submitted to the producer for review and further editing. The final Phase 2 Research Report is submitted by the D4054 Clearinghouse to the OEM review panel for review.

Producer Roles & Responsibilities
1. Work with D4054 Clearinghouse to identify and secure funding sources for Phase 2 testing.
2. Deliver specified quantity of neat test fuel produced using the specific process intended for approval to the D4054 Clearinghouse in accordance with the specified test schedule.
3. Provide specific information on the test batch of fuel relative to the process and feed stock, and any other pertinent information.
4. Support review of Tier 3 and 4 data as requested.
5. Support writing of the Phase 2 Research Report as requested.
6. Update and consult with ASTM Task Force on regular basis.

D4054 Clearinghouse Roles & Responsibilities
1. Work with OEMs and other test facilities to determine funding requirements for Phase 2 testing.
2. Work with producer to identify and secure funding sources to support Phase 2 testing.
3. Conduct in-house Tier 3 and 4 testing.
4. Arrange and coordinate 3rd party Tier 3 and 4 testing as required, and oversee test facilities as required. This may require engaging in contractual agreements or memorandums of agreement with testing facilities.
5. Distribute fuel to test facilities or coordinate with producer for direct ship of fuel to test facilities.
6. Compile Tier 3 and 4 test data.
7. Draft Phase 2 ASTM Research Report and coordinate review and editing with the producer.

Logistics
Producer should deliver specified quantity of neat test fuel in 55 gallon epoxy-lined sealed drums fuel to:

Mr. Sam Tanner
University of Dayton Research Institute
1790 Loop Rd North
Wright-Patterson AFB, OH 45433
(937) 713-0015 (office)
(937) 416-4762 (cell)
Stage 5: Phase 2 OEM Review Process
(Steps 7 & 8 of OEM Review Process)

Overview
The D4054 Clearinghouse submits the Phase 2 research report to the OEM Review Panel for review and oversees the review process. The clearinghouse coordinates with the producer to respond to any questions from the OEM Review Panel during the review process. The D4054 Clearinghouse coordinates with the OEMs to consolidate additional test and/or data requirements for submittal to the producer. The D4054 Clearinghouse conducts additional testing and provides supplemental reports as required. The D4054 Clearinghouse engages with OEM Review Team to reach final consensus regarding determination of the proposed process’s fit for purpose.

Producer Roles & Responsibilities
2. Support additional testing or data generation as requested.
3. Work with D4054 Clearinghouse to identify and secure funding sources for additional testing.
4. Deliver specified quantity of neat test fuel produced using the specific process intended for approval to the D4054 Clearinghouse as required to support additional testing.
5. Provide specific information on the test batch of fuel relative to the process and feedstock, and any other pertinent information.
6. Support review of additional test data as requested.
7. Update and consult with ASTM Task Force on regular basis.
8. Support generation of supplemental Phase 2 test/data reports as requested.

D4054 Clearinghouse Roles & Responsibilities
1. Submit Phase 2 Research Report to the OEM Review Panel.
2. Establish schedule for report review and organize periodic meetings with OEMs to review status and discuss the test results.
3. Communicate questions and responses between the OEMs and producer.
4. Work with OEMs and other test facilities to determine funding requirements for additional testing.
5. Work with producer to identify funding secure sources to support additional testing.
6. Conduct in-house additional testing.
7. Arrange and coordinate 3rd party additional testing as required, and oversee test facilities as required. This may require engaging in contractual agreements or memorandums of agreement with testing facilities.
8. Distribute fuel to test facilities or coordinate with producer for direct ship of fuel to test facilities.
9. Compile additional test data as required.
10. Draft supplemental test reports as required and coordinate review and editing with the producer.
11. Deliver final supplemental testing reports to OEM Review Panel and coordinate OEM review of these reports.
12. Engage with OEM Review Panel to support data review deliberations’ regarding the proposed process’s fit for purpose for use on aircraft and engines.
Stage 6: ASTM Balloting
(Step 9 of OEM Review Process)

Overview
Upon completion of the OEM Phase 2 review, the D4054 Clearinghouse consolidates all reports and coordinates with producer to draft final ASTM Research Report and proposed D7566 revision. The producer enters a motion with the ASTM D02.J6 subcommittee to ballot the final research report and proposed revision to D7566. The producer drafts the ballot cover page and submits proposed ballot to the ASTM D02.J ballot secretary.

Producer Roles & Responsibilities
1. Support drafting of final ASTM research report and proposed revision to D7566.
2. Enter a motion with the ASTM D02.J6 subcommittee to ballot the final research report and proposed revision to D7566.
3. Draft the ballot cover page and submits proposed ballot to the ASTM D02.J ballot secretary.
4. Support ballot process and adjudication process (if necessary).
5. Support additional testing or data generation as requested.
6. Work with D4054 Clearinghouse to identify and secure funding sources for additional testing.
7. Deliver specified quantity of neat test fuel produced using the specific process intended for approval to the D4054 Clearinghouse as required to support additional testing.
8. Provide specific information on the test batch of fuel relative to the process and feed stock, and any other pertinent information.
9. Ballot additional test data as requested.

D4054 Clearinghouse Roles & Responsibilities
1. Consolidate all reports and coordinate with producer to draft final ASTM Research Report and proposed D7566 revision.
2. Support ballot process and adjudication process (if necessary).
3. Work with OEMs and other test facilities to determine funding requirements for additional testing.
4. Work with producer to identify and secure funding sources to support additional testing.
5. Conduct in-house additional testing.
6. Arrange and coordinate 3rd party additional testing as required, and oversee test facilities as required. This may require engaging in contractual agreements or memorandums of agreement with testing facilities.
7. Distribute fuel to test facilities or coordinate with producer for direct ship of fuel to test facilities.
8. Compile additional test data as required.
9. Draft supplemental test reports as required and coordinate review and editing with the producer.
10. Support review and balloting of additional test data as required.