ASTM Qualification Process

ASTM D4054 Qualification and Approval of New Aviation Turbine Fuels and Fuel Additives

4th International Conference on Biofuels Standards

Tedd Biddle, P&W
ASTM D4054 Task Force Leader

November 14, 2012

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Engine Manufacturers' Requirements

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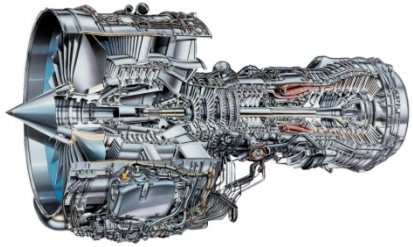
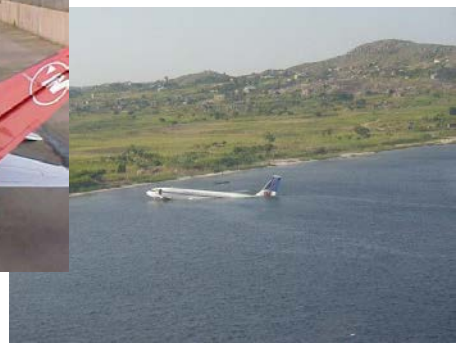
- High Energy Content

- Drop In-technology Invisible to the Engine
  - Requires no redesign, component development program, or re-certification



- Does No Harm



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How to Get a New Fuel Approved

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Two industry standards support engine and airplane manufacturer requirements and ensure there is no impact on safety, performance, or durability

Enablers

- ASTM D4054 – Qualification and Approval of New Aviation Turbine Fuels and Fuel Additives (2009)
- ASTM D7566 – Aviation Turbine Fuel Containing Synthesized Hydrocarbons (2009)
- Engage OEM, AFRL, and FAA Team for Guidance

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Overview of ASTM D4054
The Approval Process is Comprised of 3 Parts

Here's How You Get There

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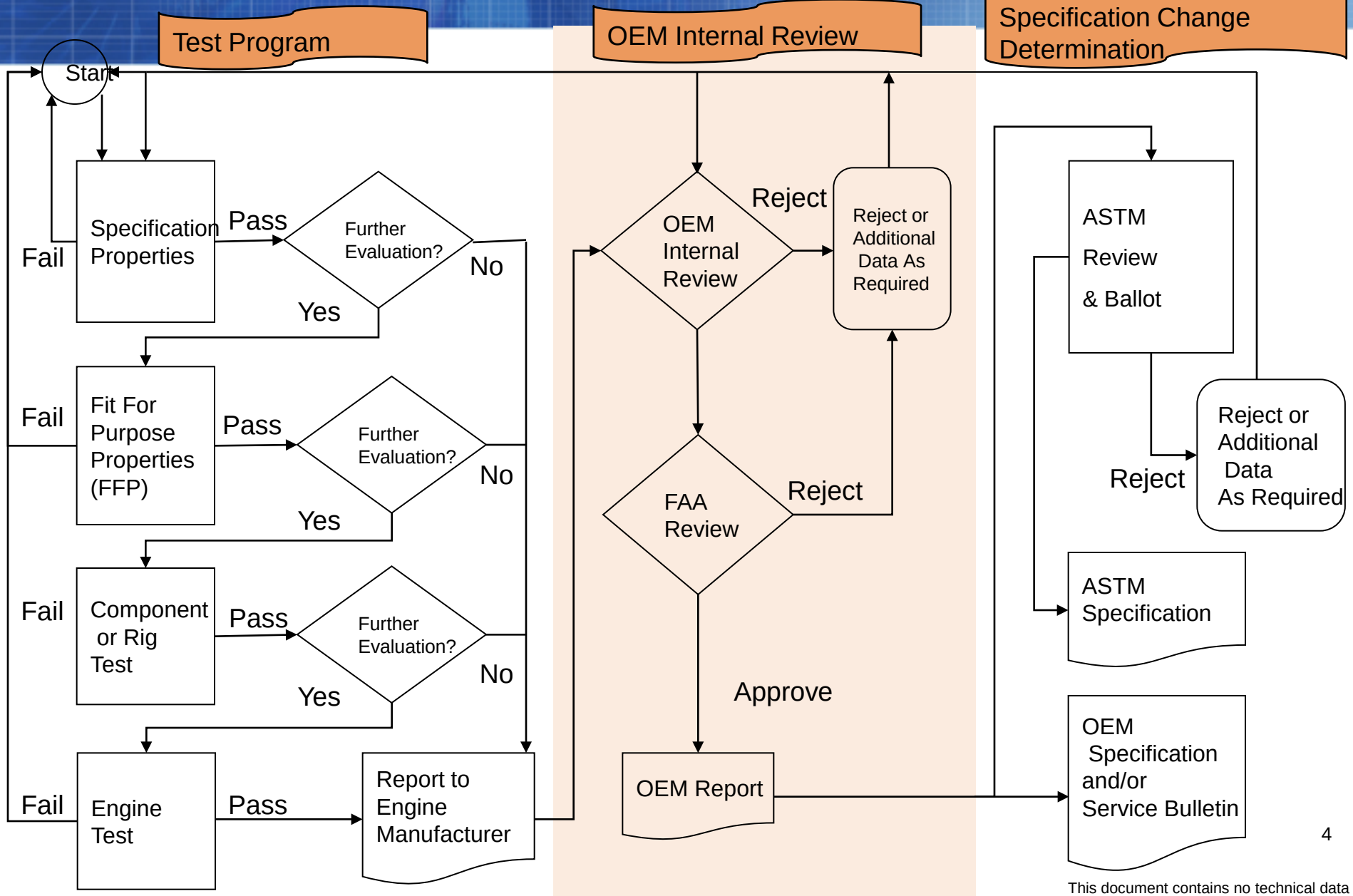

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Overview of ASTM D4054

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GOOD THINGS TO KNOW BEFORE YOU START

- *Significance and Use – Intent, Objective, and Purpose*
  - ❖ Streamline the approval process
  - ❖ Permit evaluation & approval in cost effective & timely manner
  - ❖ Guide the sponsor through a clearly defined process of testing and interactions with key participants
- *Key Participants in the Process*
  - ❖ Engine and airplane OEMs: P&W, RR, GE, HW, Boeing, Airbus
  - ❖ Regulatory authorities: FAA, EASA
  - ❖ U.S. Military: Air Force (AFRL/AFCO) & Navy
  - ❖ Airlines: no airlines – no go
  - ❖ ASTM, AFC-MOD, Coordinating Research Council, CAAFI

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GROUND RULES - CONTINUED

- *Business & Technical Case to ASTM and OEMs*
  - Somebody's got to want it (hint: airlines)
- *Disclosure of Formulation and Process to OEM Team (NDA)*
- *Formulation & Process Cannot Change Once Testing Started*
- *If Additive - Test Program Performed at 4X Concentration*
- *Funding the Investigation*
  - That would be you – i.e. your responsibility to arrange it
  - There is help
  - Engine and airplane team will typically require some level of funding

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Overview of ASTM D4054

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GROUND RULES - CONTINUED

- *OEM Internal Review and Approval (Chief Eng/Execs)*
  - ❖ Al testing must be completed and research report approved by OEMs and balloted by ASTM
  - ❖ Provide assurance process is scalable from laboratory volumes and can move to commercialization

    Examples – not requirements

    – Process must have produced 100K gallons
    – Demonstrate capability to produce 100 Bbls/day
    – Site visit of existing refinery or refinery under construction
    – Investor activity

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Test Program Comprised of Four-Tier Gated Process

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TIER 1

Specification Properties

TIER 2

Fit-For-Purpose Properties

TIER 3

Component/Rig/APU Testing

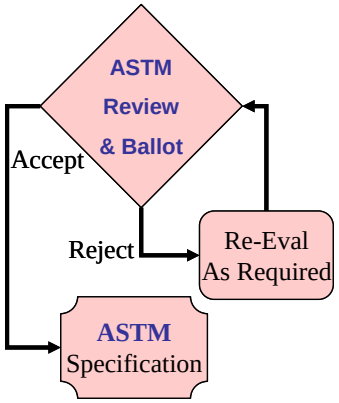
TIER 4

Engine Testing

ASTM Research Report

OEM Review & Approval

ASTM Balloting Process



ASTM Specification

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Tests Required for Each Tier are Well Defined

Tier 1
Fuel Specification Properties
Relating to Engine Safety, Performance and Durability (ASTM D 1655/ Def Stan 91-91, Mil-DTL-83133, Mil-DTL-5624)

No Effect/Positive Effect

Negative Effect

Tier 2
Fit-for-Purpose Properties

CHEMISTRY
- Hydrocarbon Chemistry (carbon number, type and distribution)
- Trace Materials

BULK PHYSICAL AND PERFORMANCE PROPERTIES
- Boiling Point Distribution
- True Vapor Pressure vs. Temperature
- Thermal Stability Breakpoint
- Lubricity
- Response to Lubricity Improver
- Viscosity vs. Temperature
- Specific Heat vs. Temperature
- Density vs. Temperature
- Surface Tension vs. Temperature
- Bulk Modulus vs. Temperature
- Thermal Conductivity vs. Temp.
- Water Solubility vs. Temperature
- Air Solubility (oxygen/nitrogen)

ELECTRICAL PROPERTIES
- Dielectric Constant vs. Density
- Electrical Conductivity and Response to Static Dissipator

GROUND HANDLING / SAFETY
- Effect on Clay Filtration
- Filtration (coalescers & monitors)
- Storage Stability
  - Peroxides
  - Potential Gum
- Toxicity
- Flammability Limits
- Autoignition Temperature
- Hot Surface Ignition Temperature

COMPATIBILITY
- With Other Approved Additives and Fuels
- With Engine and Airframe Seals, Coatings and Metallics

Unacceptable

Reject Fuel or Additive
File Report

OEM Approval
Incorporate into Fuel Specification with FAA Concensus

Component Test Required?

No

Yes

Tier 3
Component Tests *

TURBINE HOT SECTION
Oxidative or Corrosive Attack On Turbine Blade Metallurgy and Coatings (Burner Rig Test)

FUEL SYSTEM
- APU Cold Filter
- Fuel Control
- Fuel Pump
- Fuel Nozzle

COMBUSTOR RIG TESTS
- Cold starting, sea level to 10,000 feet
- Lean Blowout
- Aerial Restarting
- Turbine inlet-temperature distribution
- Combustor Efficiency
- Flow path carboning/plating
- Emissions
- Auxiliary Power Unit altitude starting

Anomolies

No Anomalies

Engine Test Required?

No

Yes

Tier 4
Engine Endurance Test *

Anomlies

No Effect

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Typical Fuel Volumes Required

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TIER 1
Specification Properties

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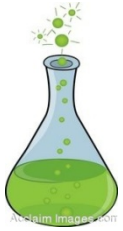
Standards Worldwide

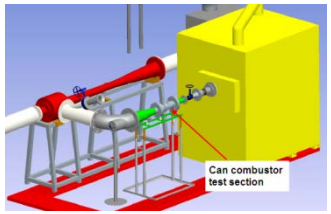


TIER 2

Fit-for-Purpose Properties

TIER 3

Component and Rig Tests



TIER 4

Engine Tests

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D4054 Experience

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D4054 Approval Protocol Based on Lessons Learned

- Sasol Semi-Synthetic fuel
- Sasol Fully Synthetic fuel
- Fischer-Tropsch Semi-synthetic fuel

Franz

Hanz

Approved

- 1 Biofuel (HEFA)
- 4 thermal stability improver additives

ASTM INTERNATIONAL
Standards Worldwide

In Process

- 1 contaminant (FAME (Fatty Acid Methyl Ester))
- 4 fuel additives (water solubilizer, corrosion inhibitor, 2 antistatic)
- 8 new fuels (SKA, 2 ATJ, CH, 2 CRJ, DSHC, HDCJ)

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Proposed Revisions and Additions to D4054

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Jack Burgazli's

ASTM D4054 "Does it Really Work"? Task Force

- Additive Performance
- Handling

Mark Rumizen's

ASTM D4054 Users' Guide

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Contacts for Help Navigating ASTM D4054 and ASTM D7566

D4054

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D7566

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AFRL Testing

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