Aviation Fuel Quality

- From Manufacturing through Distribution

Dan Kadlecek – ExxonMobil Technology and Engineering
DLA Energy Worldwide
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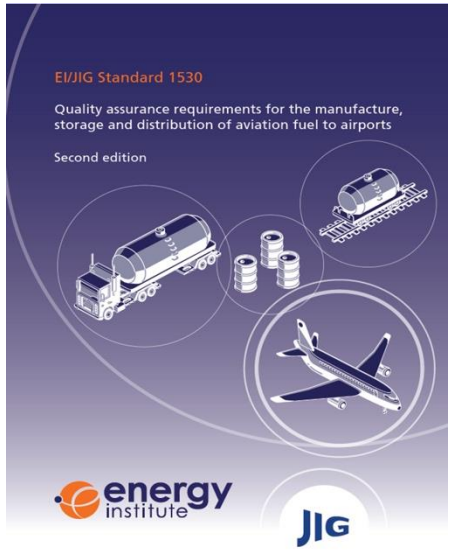
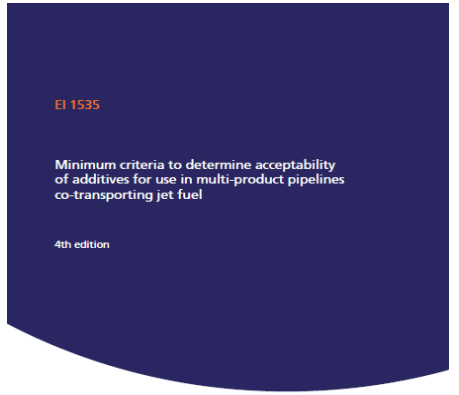
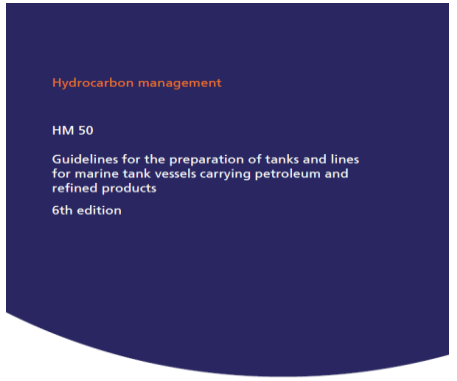
ExxonMobil

Agenda

- Jet Fuel Manufacture
  - Co-processing of non-conventional feedstocks
  - Testing and certification
- Jet Fuel Quality Assurance
  - System design
  - Fuel quality concerns in distribution
  - Fuel quality management
- Energy Institute Quality Assurance Standards
  - EI/JIG Standard 1530
  - EI Standard 1533
  - EI Standard 1535
  - EI HM 50







energy institute

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Co-Processing Refresh

Co-Processing is the simultaneous processing of both conventional and non-conventional feedstocks in an existing refinery

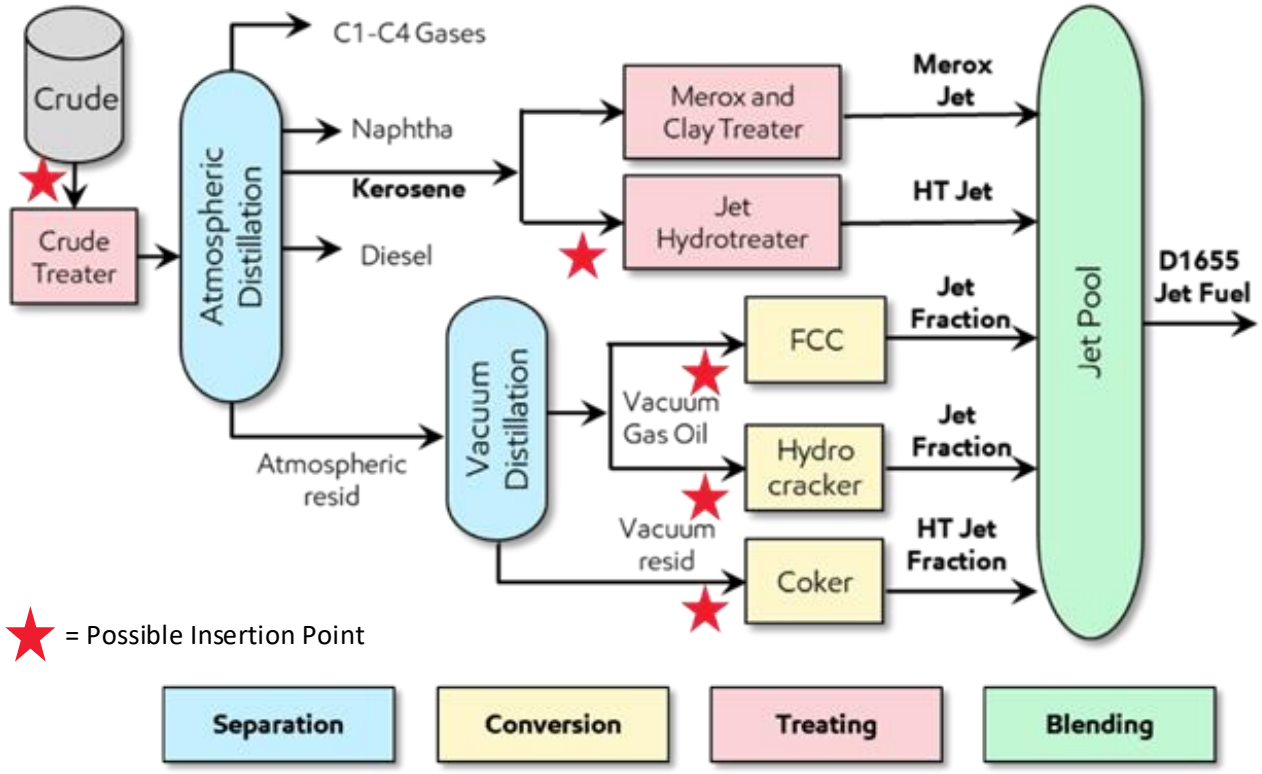
- Non-conventional feedstocks are generally considered as non-petroleum in origin

Non-conventional feedstocks may be inserted into the conventional refinery at numerous units depending on desired conversion process

All approved non-conventional feedstocks require hydroprocessing at some point in their production

Each feedstock has its own approved concentration as a percent of both feed and product

Once a co-processed fuel is tested/certified, it is handled as a conventionally-derived jet fuel



What is ‘Generic’ Co-Processing?

Scope:

- A proposal that would permit co-processing up to 5 vol% of a defined suite of ‘generic’ feedstocks with significant process and finished product controls to ensure fuel fitness for purpose

Proposed feedstock definition:

- A subset of non-conventional feedstocks derived from biomass, used tires, mixed plastic waste or liquids originating from syngas

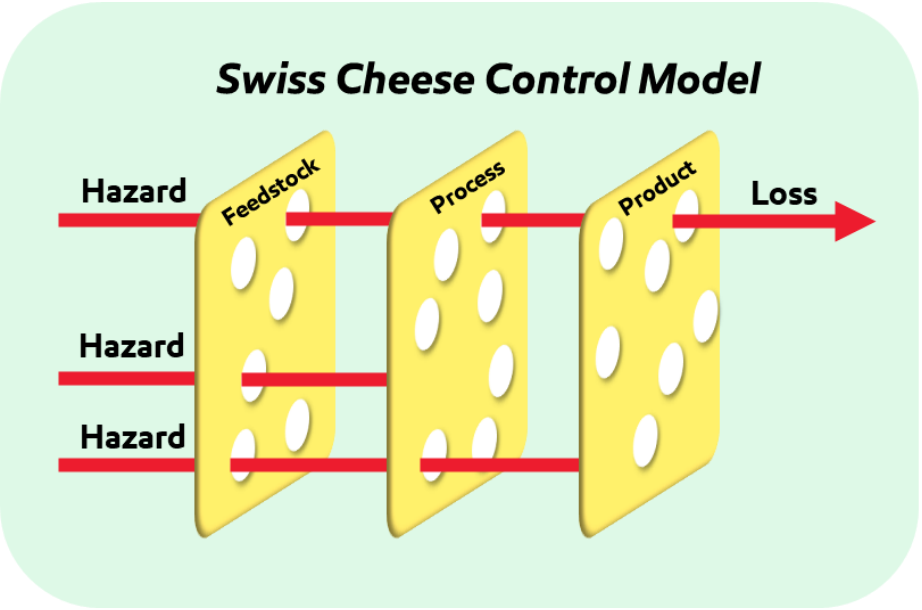
Part B – Additional requirements that apply to co-processing through A1.3.8		Limit	Test Method
Nitrogen, mg/kg	Max	20	D4629
Halogens, mg/kg	Max	1 per halogen	D7359 / UOP 991
Metals, mg/kg Al, Ca, Co, Cu, Cr, Fe, K, Mg, Mn, Mo, Ni, Pb, Pd, Sr, V, Zn Na, Pt, Sn P, Ti	Max	 0.2 0.1 1.0	D7111 or UOP 389
Ash, % mass	Max	0.01	D482
Antioxidants, mg/L	Min Max	17 24	

Proposed volumetric limits:

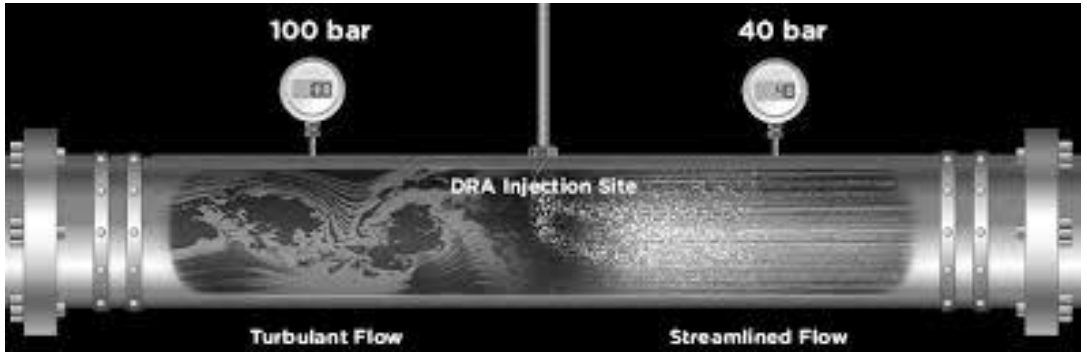
- Maximum 5 vol% feed to a jet co-processing unit and maximum 5 vol% in the finished jet product

Proposed process and product controls:

- Co-processing shall include hydroprocessing and fractionation for all streams that contain non-conventional material
- High degree of additional finished product quality testing
- Management of Change to identify any significant change in product quality

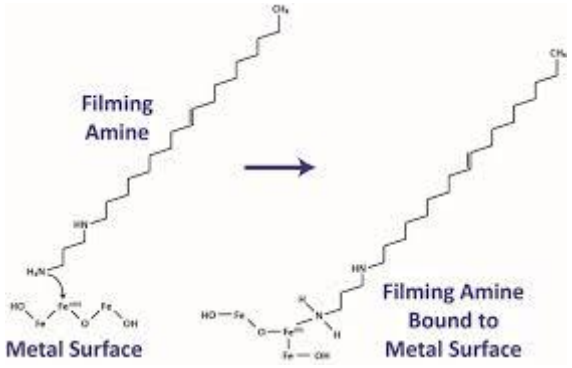


Refinery Feedstocks and Additives



- Crude oil composition can vary significantly; the refining process produces a fit for purpose fuel

- There can be unknowns that impact a fuel's fitness for purpose
  - Crude oil production additives may remain in kerosene
  - Crude oil upgrading (e.g. synthetic crudes) may result in unexpected hydrocarbons in the kerosene range (e.g. olefins)
  - Additives used in crude oil distribution (e.g. DRA)
  - Additives used in fuel production (e.g. film-forming amines)



- Slop Reprocessing
  - Refineries will often re-process returned products, off-spec products, intermediates without a home

- **Producers shall manage the quality of aviation fuels consistent with the expectations of the full text of the relevant fuel specification**

Multi-Product Pipelines

- Many multi-product pipelines require the use of corrosion inhibitors
  - These are often prohibited in jet fuels, but may be mandated for some ground fuels
  - By design, a corrosion inhibitor is a surface active agent
- Pipeline companies maintain a list of additives that are permitted in ground fuels
- Drag reducing additives may also be used in finished ground fuels
- Management of transmix can be challenging
  - May contain mixtures of gasoline, diesel and jet fuel
  - Refinery re-processing may produce new fuel products
- Pigging operations can loosen material that can cause downstream issues (e.g. scale, additives)

Corrosion Inhibitors

All products shipped on Colonial, except for all grades of aviation turbine fuel, are required to meet a minimum level of corrosion protection prior to shipment. The concentration of inhibitor dosage will be controlled to meet a minimum rating of B+ (less than 5% of test surface rusted) as determined by NACE Standard TM0172-2001, Test Method – Antitrust Properties of Petroleum Products Pipeline Cargos. Diesel and gasoline shipments may contain only the following corrosion inhibitors:

- Afton Chem 4875
- Afton Chem HiTEC 6455
- Athlon 611
- Aqua Process 11CH77
- MidContinental MCC5001
- Mobil C-605
- Nalco 5403
- Nalco 5405
- Tolad 249
- Tolad 351
- Tolad 3232
- Tolad 3232D

Effective Date 07-25-2024 4

QUALITY ASSURANCE MANUAL

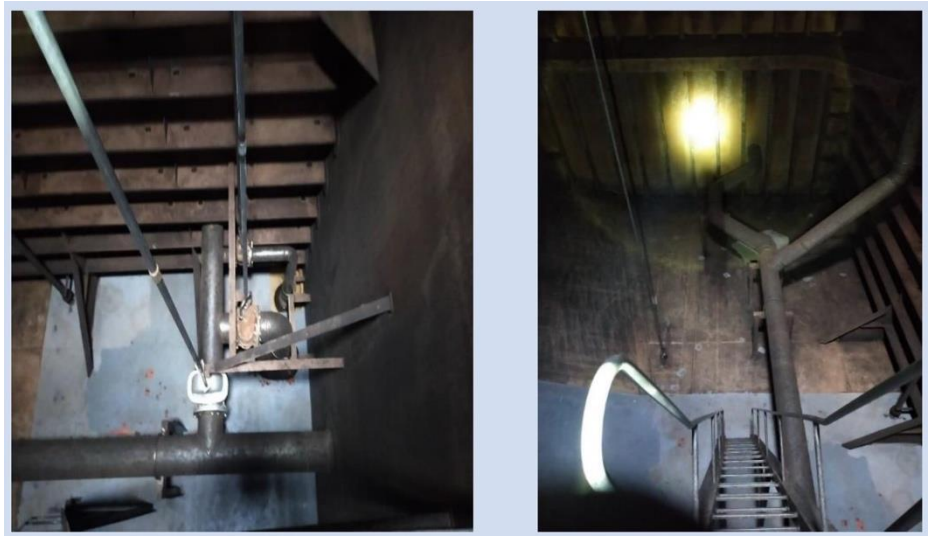
PRODUCT SPECIFICATIONS ADDITIVES

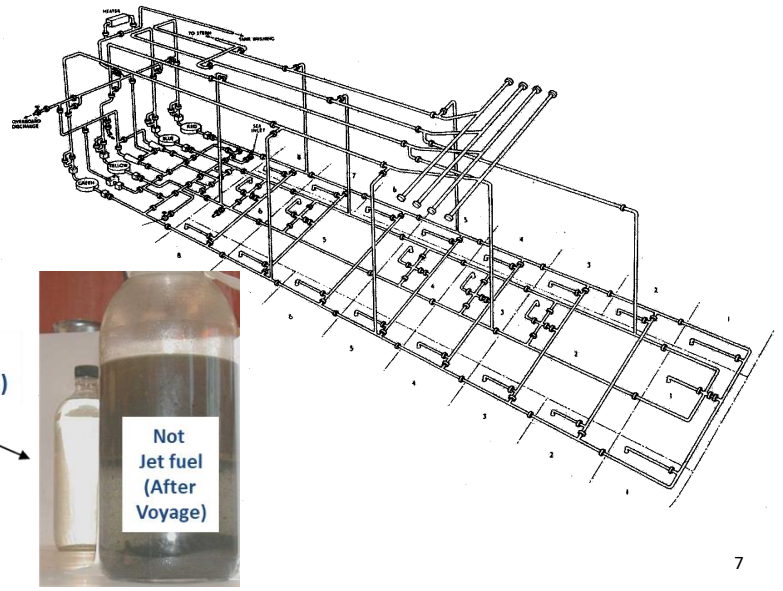
- Corexit DCI-4A
- Corexit DCI-6A
- Corexit DCI-11
- Corexit DCI-30N
- Ethyl HiTec 580
- Lubrizol 541
- Lubrizol 8014
- Lubrizol 8017
- Nalco 5406
- Nalco EC5624A
- Nalco EC5626A
- Spec-Aid 8Q22
- Spec-Aid 8Q110ULS
- Spec-Aid 8Q112ULS
- Spec-Aid 8Q123ULS
- Tolad 245
- Tolad 4410
- Unichem 7500
- Unichem 7501
- Unichem 7510
- UOP Unicor
- UOP Unicor J
- Unicor PL

In addition to the above additives, the following may be used in diesel fuel and fuel oil shipments: Dupont AFA-1, Innospec DMA-4, Nalco 5400-A.

Marine Vessels

- Marine Vessel Selection
  - What types of vessels are available and/or appropriate for the product?
  - Jet fuel vs SATF vs SBC utilizing refined fuel products, or chemicals
- Prior Cargoes
  - What were the last three cargoes for the compartments where jet is to be loaded?
  - These can be widely varying…chemical intermediates, raw vegetable oils, lubricant basestocks, caustic, etc.
- Ship Preparation
  - Depending on prior cargoes, what cleaning is required?
  - HM50 provides general guidance
- Ship Lining
  - Are the ship compartments lined? With what?
  - Some linings may not be compatible with jet fuel…e.g. some zinc silicates
- On-board Inerting
  - Is there an inerting system…exhaust gas or nitrogen?



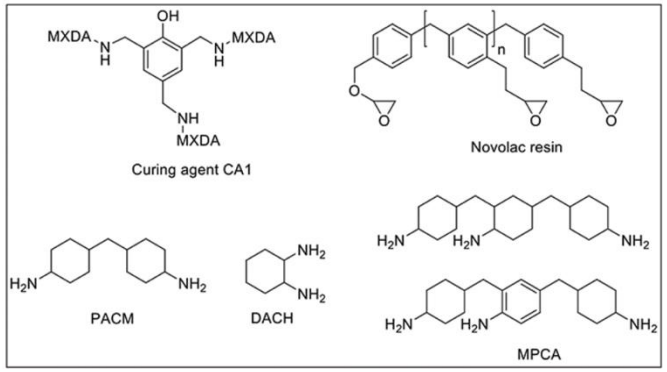


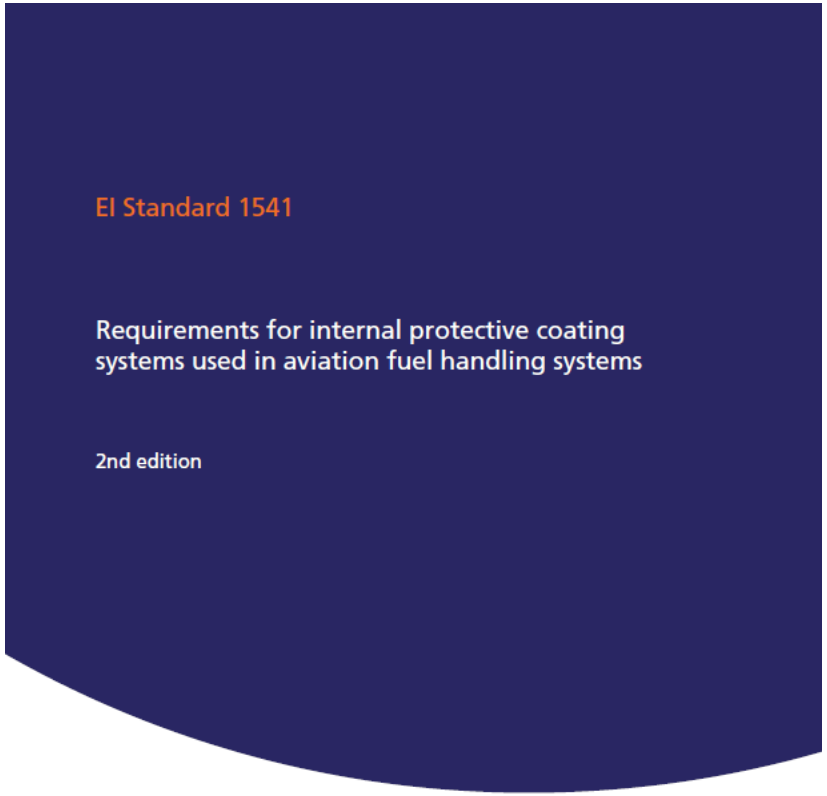
Linings (paint)

- In general, linings should be used with reference to documents like EI 1541
  - Also, MIL-PRF-23236 or Def Stan 80-97

- Preferred linings for aviation fuel systems are epoxy-phenolic
  - These are two-component, cross-linked paints that are generally inert to aviation fuel and provide good:
    - Corrosion resistance
    - Water separation

- Linings can be applied to:
  - Storage tanks
  - Marine vessel compartments
  - Piping (hydrant systems)





- Incorrect linings or improper application can lead to leaching of paint components into fuel
  - Many linings contain amine-based cross-linking curing agents