Aviation Fuel Filtration

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Aviation Fuel Filtration

– EI Specifications/Handbooks – New editions
– EI 1596 Vessel specification
– EI 1590 Microfilter
– EI 1583 Filter monitors
– 1550 handbook
– What’s new
– Water detection probes
– Q & A
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Industry Specifications (update)
Aviation publications

1550 Filtration
1560 Hydrants
1570 Sensors
1580 Equipment
1590 Operations

Upstream fuel quality
- API 1530
- API 1535
- API 1543
- API 1595

- 1529 Hoses
- 1582 Couplers pit valves
- 1584 Coatings
- 1585 Marksings
- 1586 Miss-fueling
- 1587 Meter Proving
- 1588 Testing
- 1590 Dirt Defence

Excludes research reports
- ATA 103
- JIG 1, 2, 4

Operating standards

Upstream fuel quality
- API 1530
- API 1535
- API 1543
- API 1595

- 1529 Hoses
- 1582 Couplers pit valves
- 1584 Coatings
- 1585 Marksings
- 1586 Miss-fueling
- 1587 Meter Proving
- 1588 Testing
- 1590 Dirt Defence

Excludes research reports
- ATA 103
- JIG 1, 2, 4

Operating standards
New/revised in 2013/14

Upstream fuel quality

- API 1543
- API 1595

1540 Facility Design & Construction

- ATA 103
- JIG 1, 2, 4

Operating standards

1550 Filtration
- 1596 Vessels
- 1585 Cleaning
- 1594 Testing

1560 Hydrants
- 1529 Hoses
- 1584 Couplers and pit valves

1541 Coatings

1542 Markings

1597 Miss-fueling

HM20 Meter Proving

1598 Testing

1570 Sensors

1581/2 FWS
- 1583 Monitors
- 1590 Microfilters

1599 Dirt Defence

15xx = New title/edition published
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El 1596 Filter Vessels
Filter vessels (for all filter types) – EI 1596

- EI 1596 *Design and construction of aviation fuel filter vessels, 2nd edition*, April 2013
- Provides mechanical specifications for vessels for use as FWS, filter monitors or microfilter systems
- Clarifies: internal epoxy coating requirements (ref to EI 1541); that it is not acceptable for work platforms to be welded or physically attached to vessels; that a specially installed clean-out connection is not required for vessels with an interior diameter of less than 71 cm (28 in.)
- Includes option of an automated device to ensure a pre-set dp is not exceeded in service, e.g. proximity sensor, electronic switch, pressure switch, or high point tracker (peak hold reading)
Filter vessels (for all filter types) – EI 1596

- Key addition is introduction of standardised templates for vessel data plates and operational data plates
- Printed copies of data plates (and 1582 similarity sheets) to be provided to assist record keeping by operators
- It is recommended that operators specify EI 1596 2nd ed for any new filter vessels
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EL 1590 Microfilters
EI 1590 Specification for microfilters, 3rd edition

- Published September 2014
- Testing requirements the same as 2nd ed, so all currently qualified models remain qualified to 3rd ed
- 3rd ed introduces for the first time a 10 micron rated element
- 3rd ed scope also expanded to cover the qualification of 2 inch and 4 inch nominal diameter elements
- 3rd ed scope also expanded to cover elements that are manufactured with replaceable media shrouds
- All of the above will be covered by the statement ‘qualified to EI 1590’
- Any implications for operating standards?
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EI 1583 Filter monitors
Filtration update

**El 1583 filter monitors, addendum #2 to 6th ed**

- An addendum #2 to 1583 is being finalised for issue in Sept/Oct 2014
- It clarifies laboratory testing requirements, rather than introduces any technical changes
- There will be no need for any requalifications
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- Filter monitor Operation
  - Element change out - 1 year (Manufacturer recommendation) or 22 psi
  - Not for use in FSII fuel
  - Flow rate should be optimised (avoid repeated low flow operations)
  - Consider use of blanks if necessary (guidance from manufacturers)
  - Monitor differential pressure and investigate severe changes in differential Pressure
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- **JIG Bulletin on filter monitors in draft – for issue in September**
  - Update of EI 1583 specification via addendum
    - no impact on operations
  - Reminder of the operational parameters
  - When changing out 6” filter monitors EI 1583
    6th edition shall be used
  - All filter monitor vessels shall have 6th edition
    elements fitted by December 2014
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EI 1581/2
El 1582 Similarity for FWS, addendum to 2nd ed

- An addendum to 1582 issued in Aug 2014 (dated 4 Oct 2013)
- It formally documents amendments to the similarity data sheet; the excel version of which was circulated to manufacturers in Oct 2013 (as Issue 2) for their use
- Issue 2 corrected functioning of some excel cells, and added two extra rows for information (on blank elements)
- EI 1582 2nd edition similarity sheets issued since Dec 2011 do not therefore need to be reissued
- Inspectors comparing similarity sheets with the printed version of 1582 2nd ed may find discrepancies
- Similarity sheets issued since Oct 2013 should have 63 rather than 61 rows – which is correct if compared with the addendum (free to download from EI website)
Filtration update

**El 1550 Filtration handbook**

- Draft 2\(^{nd}\) edition has been reviewed with filter manufacturers and EI committee
  - Includes four new chapters (DP, filter installations, management of change and plugs/caps)
  - Includes significant updates to seven other chapters
- Draft was issued for industry review until 16 Dec 2013. See [www.energyinst.org/filtration](http://www.energyinst.org/filtration)
- Considerable feedback is being resolved
- Publication before year end 2014
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What’s in the pipeline
Filtration Update

New developments?

• Consideration is being given to differential pressure correction and whether this offers any benefit for trend analysis compared with $dp$ at maximum operating flowrate
• Single element vessels for small applications, e.g. helicopter fuelling. Proposals being considered to run performance tests under a new spec
• Amendments to filter/water separator arrangements
Filtration Update

New developments cont’d?
• Evaluation of bulk water detector sensors
• Validating lab methods for assessing impact of diesel additives on jet fuel, for pipeline use
• Leading IATA Task Force on super-absorbent polymer
• Assessment of electrostatic charging (streaming current) downstream of final filtration
• Development of a test method for the performance of chemical water detectors – ASTM activity
Filtration Update

**Bulk water detection probes**
- Simple Go No-GO Devices to provide shut down in the event of bulk water
- Primarily for Hydrant dispensers
- Non quantitative devices

**Status**
- Initial testing done at Thornton in the UK
- Further testing currently underway at SwRI

**Challenges**
- Avoidance of nuisance factor
- Developing a culture of technology dependence – Operators should know their systems
- How do we test them?
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Water sensor trial
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Additional slides
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Differential Pressure Correction
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• Differential Pressure Correction
• To ensure that the filtration system is not exposed to conditions outside of the elements qualified dirt/water removal performance envelope.
• Can still be done manually
• Option for automatic systems
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- Differential Pressure Sensing and correction
Differential Pressure

Manufacturers agreed to review a common process for dP correction by end of 2013

Review of differential pressure measurement on small vessels underway (helicopter refuelling etc)
Differential Pressure Switches
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- Differential pressure switches
- To ensure elements are not subjected to elevated differential pressure
- JIG operations are mandated to fit some type of device to hydrant vehicles
Commonly used Equipment

Gammon Gauge

Basic model – most common in Shell operations

The peak-hold feature locks the piston at the highest reading

DP Pilot – proximity switch / control system. Air powered or electrically powered versions are available

Conversion kits available for existing gauges
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• Differential pressure switch
  – Piston differential pressure gauges used to provide $dP$ - In-line pressure devices are an option but will require further processing
  – Operational pressure to be set at a pre-set level – 22psi
  – Note: Industry investigating options of water probes to provide additional information – ongoing study for 2014
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- Differential pressure -Summary
  - Better education required on differential pressure measurement, correction and implication for operation
  - Options for new technology to help
  - New technology dP switches mandated for hydrant vehicles
  - Challenge: What do you do in the event of a lock out? – JIG guidance in place
  - Do we have supervisor intervention?
Do we need to correct differential pressure?
Differential Pressure discussion

- Robust control of filtration if done properly
- Often done incorrectly – different correction target
  flow rate
- Often poorly documented
- Filter media is stressed to the dP at the time
- Does not protect when under the wing if correction done manually
- dP switches will help
- Does not help if there is a pressure drop (system failure)
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Similarity & Compliance
EI 1582 similarity for filter/water separators

- EI 1582 2\textsuperscript{nd} edition was published in December 2012
- A standardized similarity sheet has been specified (for the first time)
- This has been made available to manufacturers as an Excel spreadsheet
- It is the expectation that manufacturers, or their representatives, provide the similarity sheets
- A vessel that does not have positive water drainage cannot comply with 1581 via similarity
- An ‘Issue 2’ of the electronic similarity sheet has been reissued to manufacturers (Oct 2013) to address their feedback
EI 1582 Similarity

Why

To ensure vessels always meet the performance requirements of EI 1581
To minimize the number of full scale tests required.
To allow interchangeability between suppliers
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Similarity & Compliance

• 2nd ed published Dec 2011

• Mandates use of standard sheet

Interchangeability
EI 1582 Similarity

Challenges

• Vessels are in service for a long period (up to 40 years)

• Specifications change to meet changing needs and vessel requirements change (API withdrawal)

• Interchangeability of elements (different manufacturers) is required

• Similarity becomes an issue of compliance (Qualification v in-service) e.g. positive water drain
Similarity - Considerations

• Orientation – Vertical or Horizontal
• Flow Pattern
• Coalescer & Separator - the same
• Element spacing
• Element types
• Flow per unit area
• Separator Entrance/Face velocity
• Element/Vessel Ratio’s
  • Void Volume
  • Void volume ratio
  • Sump volume
Carbon steel vessels to be internally coated with light-coloured epoxy coating
- Vertical vessels – lid fall prevention device
- Anti-vibration plate (spider) – the free ends of all cartridges greater than 46 cm (18 in.) long shall be stabilised to minimise vibration.
- Thermal (pressure) relief valve
- Automatic air eliminator
API/EI 1581 5th Edition / API/EI 1596 1st Edition
Vessel Mechanical Compliance Assessment

• Direct reading pressure differential gauge with stainless steel sensing lines
• Length to diameter ratio for vertical vessels
• Clean-out/inspections connection
• Work platform, access steps and handrails
• Electrical continuity – all metal items inside the vessel shall be in electrical contact with each other and the vessel body. The resistance between any two items shall be less than 10 ohms.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>SI units</th>
<th>Qualified Vessel</th>
<th>Candidate Vessel</th>
<th>Pass/Fail</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel Manufacturer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vessel Model Number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vessel Serial Number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EI 1581 Category (2.6)</td>
<td></td>
<td></td>
<td></td>
<td>Fail</td>
<td>Category must be the same</td>
</tr>
<tr>
<td>EI 1581 Type (2.6)</td>
<td></td>
<td></td>
<td></td>
<td>Fail</td>
<td>Type must be the same</td>
</tr>
<tr>
<td>Number of Element Stages</td>
<td>EA</td>
<td></td>
<td></td>
<td>Fail</td>
<td>Stages must be the same</td>
</tr>
<tr>
<td>Vessel configuration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orientation (2.2a)</td>
<td></td>
<td></td>
<td></td>
<td>Fail</td>
<td>Orientation must be the same</td>
</tr>
<tr>
<td>Vessel Inside Diameter</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Element Layout (2.2b &amp; 2.4)</td>
<td></td>
<td></td>
<td></td>
<td>Fail</td>
<td>Layout must be the same</td>
</tr>
<tr>
<td>Sump</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location (2.2c)</td>
<td></td>
<td></td>
<td></td>
<td>Fail</td>
<td>Location must be the same</td>
</tr>
<tr>
<td>Volume (2.2c)</td>
<td>cm³</td>
<td></td>
<td></td>
<td>*</td>
<td>Candidate must be &gt; or = to Qualified</td>
</tr>
<tr>
<td>Inlet Connection Position (2.2d)</td>
<td></td>
<td></td>
<td></td>
<td>Fail</td>
<td>Inlets must be in the same location</td>
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<tr>
<td>Outlet Connection Position (2.2d)</td>
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<td></td>
<td></td>
<td>Fail</td>
<td>Outlet must be in the same location</td>
</tr>
<tr>
<td>Element mounting positions (2.2e)</td>
<td></td>
<td></td>
<td></td>
<td>Fail</td>
<td>Location must be the same</td>
</tr>
<tr>
<td>Water Defense System Present?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated flow of vessel (2.5)</td>
<td>l/s</td>
<td></td>
<td></td>
<td>Fail</td>
<td>Candidate must be &lt; or = to Qualified</td>
</tr>
<tr>
<td></td>
<td>1st Stage (filter/coalescer element)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>---</td>
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</tr>
<tr>
<td>23</td>
<td>Model Number (2.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Quantity</td>
<td>EA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Number of Elements/Cartridges in Stack</td>
<td>EA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Element/Cartridge Overall Length</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Element/Cartridge Effective Media Length</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Outside Diameter</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Spacing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Between 1st Stage Elements (2.3a)</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Between 1st &amp; 2nd Stage Elements (2.3c)</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Between 1st Stage Elements &amp; Vessel (2.3d)</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Mean Linear Flowrate (2.7)</td>
<td>lpm/cm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Volume</td>
<td>cm³</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>2nd Stage (separator element)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Model Number (2.6)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Quantity</td>
<td>EA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Number of Elements/Cartridges in Stack</td>
<td>EA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Element/Cartridge Overall Length</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>Element/Cartridge Effective Media Length</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Outside Diameter</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Spacing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>Between 2nd Stage Elements (2.3b)</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45</td>
<td>Between 2nd Stage Elements &amp; Vessel (2.3d)</td>
<td>mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Length/Outside Diameter (L/D) Ratio (2.6)</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>47</td>
<td>Liquid Entrance Velocity (2.8)</td>
<td>m/s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>Volume</td>
<td>cm³</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fail: Candidate must be > or = to Qualified

Failure criteria met:
- Between 1st Stage Elements (2.3a)
- Between 1st & 2nd Stage Elements (2.3c)
- Between 1st Stage Elements & Vessel (2.3d)
- Mean Linear Flowrate (2.7)
- Volume of all 2nd Stage Elements
### 3rd Stage (filter monitor elements in separators)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>Model Number</td>
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</tr>
<tr>
<td>51</td>
<td>Quantity</td>
<td>EA</td>
</tr>
<tr>
<td>52</td>
<td>Quantity per 2nd Stage Separator</td>
<td>EA</td>
</tr>
</tbody>
</table>

### Vessel

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>54</td>
<td>Length of Vessel</td>
<td>mm</td>
</tr>
<tr>
<td>55</td>
<td>Vessel Volume</td>
<td>cm³</td>
</tr>
<tr>
<td>56</td>
<td>Vessel Void Volume</td>
<td>cm³</td>
</tr>
<tr>
<td>57</td>
<td>Positive water drainage (2.10)</td>
<td>Fail</td>
</tr>
</tbody>
</table>

### Area Ratio

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>59</td>
<td>Void Volume Ratio (2.9)</td>
<td>Fail</td>
</tr>
<tr>
<td>60</td>
<td>$\sum S_{Ae}/A_{CV} (2.9a)$ Side-by-side</td>
<td>N/A</td>
</tr>
<tr>
<td>61</td>
<td>$\sum S_{Ae}/A_{CV} (All elements to vessel) (2.9b)$ End opposed</td>
<td>N/A</td>
</tr>
</tbody>
</table>

For the candidate system to meet EI 1581 by similarity, each entry is required to produce a pass in the pass/fail column. Data are not required in any cells shaded grey.

The passes above confirm that the candidate vessel meets all requirements of EI 1582 2nd edition, and therefore is qualified to EI 1581 5th edition.

Name: ____________________________  Company: ____________________________

Signed: ____________________________  Date: ____________________________
A FWS system can meet the performance requirement of EI 1581 5th edition but may not meet all the mechanical requirements – The system is said to meet the performance requirements of EI 1581 5th edition.

It is only possible in a pre-1581 5th edition a vessel for the FWS to meet the performance requirements of 5th edition if the vessel has positive water drainage. (Positive water drainage has been a requirement for new 1581 FWS vessels since 1989.)

Non conformance to be managed (Not evergreen)
Aviation Fuel Filtration

• Similarity Sheets
• Request from the filter supplier one for each vessel – store locally with Vessel operation data
• Manufacturer to provide similarity sheet – End user to check to ensure compliance
• There may be compromises in vessel performance
• Non compliance to be managed – NOT evergreen
For further information see

www.energyinst.org
www.energypublishing.org

or contact:

mhunnybun@energyinst.org

Your technical feedback on draft versions of our publications is valuable, and assists the broader industry with the sharing of good practice/experiences. Please participate.
## Aviation Fuel Filtration

### Previous involvement with API

<table>
<thead>
<tr>
<th>Pre-1999</th>
<th>2000-2010</th>
<th>Post- 1(^{st}) July 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airports Safety Code Monitors Microfilters</td>
<td></td>
<td>15 jointly-published titles - filtration, hoses, pit valves &amp; couplers, hydrants, marking, misfuelling, coatings</td>
</tr>
<tr>
<td>1529</td>
<td>1542</td>
<td>1581</td>
</tr>
<tr>
<td>Companies commenting via two processes with different perspectives</td>
<td>US and International perspectives consolidated in one process</td>
<td>US and International perspectives remain consolidated in one process</td>
</tr>
</tbody>
</table>
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Any questions?
Thank You
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Industry Specifications (update)