



# Federal Aviation Administration

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## Memorandum

Date: November 23, 2015

To: Manager, Boeing Aviation Safety Oversight Office, ANM-100B

From: Manager, Transport Airplane Directorate, ANM-100

Prepared by: Jim Voytilla, ANM-100B

Subject: INFORMATION: Equivalent Level of Safety (ELOS) Finding for Warning Means for Engine Fuel Filter Contamination on Boeing Model 787-8/-9/-10 (Project Nos. TC6918SE-T, PS06-0496, PS06-0497, PS13-0546 and PS14-1031)

ELOS Memo #: TC6918SE-T-P-20

Regulatory Ref.: §§ 25.997 and 25.1305(c)(6)

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This memorandum informs the certificate management aircraft certification office of an evaluation made by the Transport Airplane Directorate (TAD) on the establishment of an equivalent level of safety (ELOS) finding for the Boeing Model 787-8 airplane.

This memo was subsequently revised to extend this ELOS to the Boeing Model 787-9 and 787-10 airplanes.

### **Background**

The regulatory requirements for filtering the fuel pumped from the airplane fuel tanks to each engine are defined in Title 14, Code of Federal Regulations (14 CFR) 25.997, "Fuel strainer or filter." This requirement states that "there must be a fuel strainer or filter between the fuel tank outlet and the inlet of either the fuel metering device or the engine driven positive displacement pump whichever is nearer the tank outlet." This strainer or filter must also "have a capacity to ensure that the engine fuel system is not impaired with the fuel contaminated to a degree greater than that established for the engine during the part 33 certification."

Section 25.1305(c)(6) requires "an indicator for the fuel strainer or filter required by § 25.997 to indicate the occurrence of contamination of the strainer or filter before it reaches the capacity established in § 25.997." The indications and indication requirements associated with the strainer and the filter are not addressed in this ELOS finding.

The engine fuel filtration system on the Boeing Model 787 equipped with GENx engines incorporates a “strainer + filter” system. The strainer, which includes a bypass provision, is located upstream of the engine driven positive displacement pump (EDP) in a location that meets the requirement in § 25.997. However, that strainer does not meet the capacity requirements of § 25.997. The engine also incorporates a fuel filter downstream of the fuel pump that meets the capacity requirements of § 25.997, but is not in the required location. Since the design of the fuel filtering scheme does not directly comply with the prescriptive rules cited above, Boeing requested an equivalent level of safety finding for § 25.997.

**Applicable Regulation(s)**

§§ 25.997 and 25.1305

**Regulation requiring an ELOS**

§ 25.997(d)

**Description of compensating design features or alternative standards which allow granting of the ELOS (including design changes, limitations or equipment need for equivalency)**

The design of this fuel filter system employs not one filtering device as described by § 25.997, but two filtering devices, a strainer upstream from the filter. The fuel strainer is capable of removing the large contaminants from the fuel before they reach the engine driven pump. While this strainer does not meet the filter capacity requirements of § 25.997(d), the fuel pump is expected to operate without damage pumping strained fuel even if fine debris that passes through the strainer is present. An additional fuel filter located downstream of the pump and upstream of the fuel metering unit then removes smaller contaminants before they reach the fuel metering unit. This additional filter meets the capacity requirements of § 25.997(d). Both the strainer and filter have bypass capability, and differential pressure sensing to allow fuel bypass to be indicated.

The strainer and filter combination have been tested to show that in combination they satisfy the installation and performance requirements of § 33.67.

The airplane fuel system design also includes center wing fuel pump inlets that are located well above the bottom of the fuel tank and in separate bays within the tank. This design significantly reduces the likelihood of large hard body debris such as nuts, bolts washers etc. from causing a common cause contamination event that could affect both engines. Hard body debris such as bolts would remain near the bottom of the tank, well below the fuel pump inlets so that it would be unlikely for this debris to be fed to the engines. The existing GENx engine also incorporates a differential pressure sensor across the fuel strainer that under certain conditions provides engine indicating and crew alerting system (EICAS) status messages and central maintenance computer (CMC) messages for additional awareness.

**Explanation of how design features or alternative standards provide an equivalent level of safety intended by the regulation**

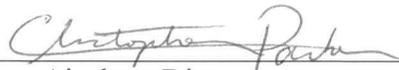
The Boeing Model 787 GENx-1B fuel system design provides adequate component specific damage protection for both the engine driven pump and the engine fuel metering unit, which was ultimately the intent of the prescriptive requirements of § 25.997. Unlike the arrangement prescriptively required by § 25.997, the GENx-1B arrangement has the added benefit of protecting the fuel metering unit and fuel nozzles from debris that can be generated by a deteriorating engine fuel pump, which may prevent certain engine failures.

As stated above, the indication issues related to this alternative filter arrangement are addressed separately and are not part of this ELOS.

**FAA approval and documentation of the ELOS finding**

The FAA has approved the aforementioned ELOS finding in Issue Paper P-20 or Administrative Collector Issue Paper G-6. This memorandum provides standardized documentation of the ELOS finding that is nonproprietary and can be made available to the public. The TAD has assigned a unique ELOS memorandum number (see front page) to facilitate archiving and retrieval of this ELOS. This ELOS memorandum number must be listed in the type certificate data sheet under the certification basis section.

Equivalent Safety Findings have been made for the following regulation(s):  
§ 25.997(d) Fuel Strainer or Filter (documented in TAD ELOS Memo TC6918SE-T-P-20)



Transport Airplane Directorate,  
Aircraft Certification Service

12/3/2015

Date

ELOS Originated by Seattle ACO	Project Engineer Sue Lucier	Routing Symbol ANM-140S
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