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To: [Horgan Carol](#)
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Subject: Email report (ENG16IA027-O-ring samples)
Date: Thursday, June 22, 2017 3:20:34 PM

Carol,

Two samples from an engine joint on the accident aircraft were submitted to the Materials Laboratory for examination. One sample was labeled "IN" was material removed from the engine joint after the joint was opened and separated. The other sample, labeled "OUT", was material recovered from the exterior of the engine joint. Both samples were curved, blue, and consistent with portions of O-rings.

The surfaces of both samples were soft and gummy and the surface was easily deformed by pressure. This surface texture change is consistent with polymer reversion, the breakdown of cross-linking bonds that give the polymer its strength and elasticity. The sample labeled OUT had more significant material reversion than the IN sample. In addition to the soft and tacky texture, the OUT sample exhibited flaking and delamination of the material from the outer surface of the O-ring. Reversion can occur due to exposure to high heat or non-compatible chemicals/materials.

The accident O-rings were examined using a Fourier Transform Infrared (FTIR) spectrometer with a diamond attenuated total reflectance (ATR) accessory in accordance to American Society for Testing Materials standard E1252-98, *Standard Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis* (ASTM E1252-98). The spectrometer was used to collect and process infrared wavelength absorbance spectra of the unknown material.

The spectrum contained spectral peaks that corresponded to particular functional groups found within molecular structure of the unknown material including the following peaks: a doublet peak at $\sim 2964\text{ cm}^{-1}$ and $\sim 2910\text{ cm}^{-1}$ corresponds to a carbon-hydrogen stretching bond. A single peak at $\sim 1447\text{ cm}^{-1}$ indicative of a carbon-hydrogen (2) bending bond. A single peak at $\sim 1369\text{ cm}^{-1}$ indicative of a carbon-hydrogen (3) bending bond. Another doublet peak at $\sim 1263\text{ cm}^{-1}$ and $\sim 1207\text{ cm}^{-1}$ indicative of a silicon-methyl (CH_3) bond. A doublet peak at $\sim 1061\text{ cm}^{-1}$ and $\sim 1007\text{ cm}^{-1}$ indicative of a silicon-oxygen-silicon bond. Carbon-fluoride bonds can also have spectral peaks in this area. A single peak at $\sim 896\text{ cm}^{-1}$ is also indicative of a carbon-hydrogen (2) bending bond. A doublet peak at $\sim 797\text{ cm}^{-1}$ and $\sim 765\text{ cm}^{-1}$ indicative of a silicon-carbon bond. This spectral pattern was consistent with a straight-chained siloxane.

The spectra from both samples were compared to known spectra in a spectral library. The search found a strong spectral match to fluorosilicone rubber. This is consistent with the material listed in specification for the fuel fitting which states that the O-rings should be a Type 1 Class 1 Grade 60 rubber fluorosilicone/elastomer.

If you have any questions, please feel free to contact me.

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