

Alternative O-Rings for Hypergolic Propellant Systems

O-rings are used in many NASA propulsion systems to seal high pressure lines that contain liquid engine propellants and gases. Production of a widely-used commercial O-ring, compatible with these liquids and gases, was discontinued due to lack of a key compound ingredient. The NESC engaged O-ring and material manufacturers and performed extensive materials compatibility testing to find suitable replacements. These replacement candidates are still awaiting qualification to NASA design and construction standards (e.g., NASA-STD-6016, etc.).

Background

Parker-Hannifin has stopped making O-rings with E0515-80, an ethylene propylene diene monomer (EPDM) material often used in hypergolic propellant systems. Production was halted due to a supplier of an E0515 compound ingredient unexpectedly and suddenly ceasing operations in late 2018. The O-rings are used in many NASA programs. An NESC assessment team was formed and planned to test several candidate replacement materials to avoid future dependence on a single material. While the E0515 O-rings are used in multiple applications across NASA, the use of the rings in hypergolic propellants is of particular interest. Parker-Hannifin suggested another in-house material, EM163, as the replacement for E0515. EM163 is a Shore M 80-durometer EPDM material, certified to NAS1613 Rev. 6, a specification for use in hydraulic fluid systems. Note that E0515 was certified to NAS1613 Rev. 2. The main difference between Rev. 2 and Rev. 6 is the requirement to be compatible with additional hydraulic fluids. Parker-Hannifin expects EM163 to perform similarly to E0515 but did not perform testing for hypergolic propellant compatibility.

Replacement Materials Testing and Results

The NESC assessment team chose six candidate materials for testing as possible E0515 replacements. The assessment team also contacted several material compounding firms in the event none of the six candidate materials were found to be compatible. Short and long-duration tests were performed in accordance with standard testing procedures. Figure 1 shows unexposed and exposed Park-Hannifin E0515 O-rings from the short-duration testing. Two of the candidate materials, including the EM163 material suggested by Parker-Hannifin, were eliminated from consideration after short-duration testing.

Three materials, Parker E0540, Precix E152, and Parco 5778-80, successfully completed short- and long-duration testing and are considered compatible replacements for Parker E0515 in hypergolic propellant applications. One material, Freudenberg-NOK E458, gave mixed results during the short- and long-duration testing and is considered a compatible replacement for Parker E0515 in limited hypergolic propellant applications.

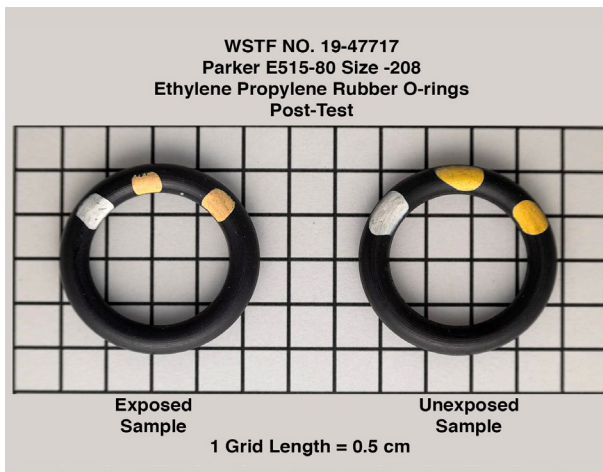


Figure 1. Unexposed and exposed Parker-Hannifin E0515 O-Rings.

References

1. ASTM D395, Standard Test Methods for Rubber Property—Compression Set.
2. NASA-STD-6001B, Flammability, Offgassing, and Compatibility Requirements and Test Procedures, April 21, 2016.
3. Parker O-Ring Handbook, ORD-5700, Parker Hannifin Corporation, Cleveland, OH, 2018.

