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Aerospace - Chlorinated Solvent Contamination of
MIL-H-5606/MIL-H-83282 Vehicle Hydraulic Systems

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

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FOREWORD

In June 1982 a study entitled "Investigation of Air Force MIL-H-5606 Hydraulic System Malfunctions Induced by Chlorine Solvent Contamination" (AFWAL-TR-82-4027) was issued by the Air Force Wright Aeronautical Laboratories (AFWAL/MLB) and the University of Dayton Research Institute (Bibliography 1). Information in that study reported that in 1975 a large number of C-141 mishaps occurred involving stuck selector valves in landing gear and door systems throughout the Military Airlift Command (MAC). Analysis of hydraulic fluid from a problem aircraft hydraulic system revealed the presence of the chlorinated solvent 1,1,2- trichlorotrifluoroethane and water. Auger spectroscopy surface analysis of the stuck valve and spool assembly involved revealed the presence of elements chlorine, oxygen, iron, and carbon. With this proof of chlorinated solvents being the cause of stuck valves in a C-141 mishap, a fleet wide survey of aircraft hydraulic systems was performed to determine the level of chlorinated solvents and water in hydraulic systems. Simultaneously, maintenance overhaul procedures were modified to eliminate the use of chlorinated solvents as much as possible. A maximum limit was tentatively established for chlorine contamination in C-141 hydraulic systems at 200 parts per million (ppm) chlorine, based on the Navy's success with a 200 ppm limit with the P-3 aircraft. Upon establishing this limit, C-141 aircraft were drained and flushed if their systems exceeded this limit. The use of chlorinated solvents was banned from use in the C-141 hydraulic systems and component overhauls. As a result of that study, a level of 200 ppm maximum allowable chlorine limit was established.

- a. Summary: Chlorine contamination of aircraft hydraulic fluids has been known to cause considerable amounts of damage to hydraulic flight control systems and their corresponding component parts. In an effort to statistically reveal the origins of, and the damages caused by chlorine contamination, a survey was presented to randomly selected aerospace corporations and government organizations by the Fluids Panel of Committee A-6. Based on the preliminary data, a problem exists with chlorine contamination in hydraulic systems. Data contained in a follow-up survey identified chlorofluorocarbon based cleaning fluids as the common chlorine containing fluid in use.

The source of the chlorine containing contaminants is primarily solvents used in cleaning/degreasing of aircraft parts. Care must be exercised when such solvents are specified to minimize all opportunities for their being introduced into the hydraulic fluid. Such solvents are normally miscible with the hydraulic fluid and their presence can only be determined by laboratory analytical techniques such as those outlined in this document.

- b. Types and Percentages Measured: During 1975 and 1976 hydraulic fluid samples were taken from Air Force aircraft at various bases. Aircraft sampled included C-141, B-52, F-105, F-111, F-4, T-38, C-5A, KC-135, F-106 aircraft, and crash accident samples. Also sampled were test stands, servicing carts, and new hydraulic fluids in order to study when and how the chlorinated solvents were introduced into operational hydraulic systems. When these initial samples were taken, chlorine content was measured at the various ALC laboratories by x-ray fluorescence techniques which were later recognized to contain possible serious analytical errors. While any particular data point could be in question, the overall trends of chlorine contamination in hydraulic fluids are considered to be valid.

c. Analysis Results: Of the 250 aircraft fluid samples analyzed, results are given in parts per million chlorine, number of samples analyzed with that value, and the percentage of the total samples.

- (1) 300 ppm and above: 1 sample, < 1%
- (2) 200 - 300 ppm: 5 samples, 2%
- (3) 100 - 199 ppm: 38 samples, 15%
- (4) 0 - 100 ppm: 205 samples, 82%

Of the ground equipment fluid samples (703 total), 52% contained over 200 ppm chlorine. Of the new fluid samples analyzed (25 total), 8% were over 200 ppm chlorine.

It can be seen from this data that ground support equipment and new fluid can be a source of contamination. These data further document that the then current levels of chlorine in hydraulic fluid systems were at a serious level, Air Force wide, as these chlorinated solvent levels were in the ranges which had caused corrosion in Navy aircraft.