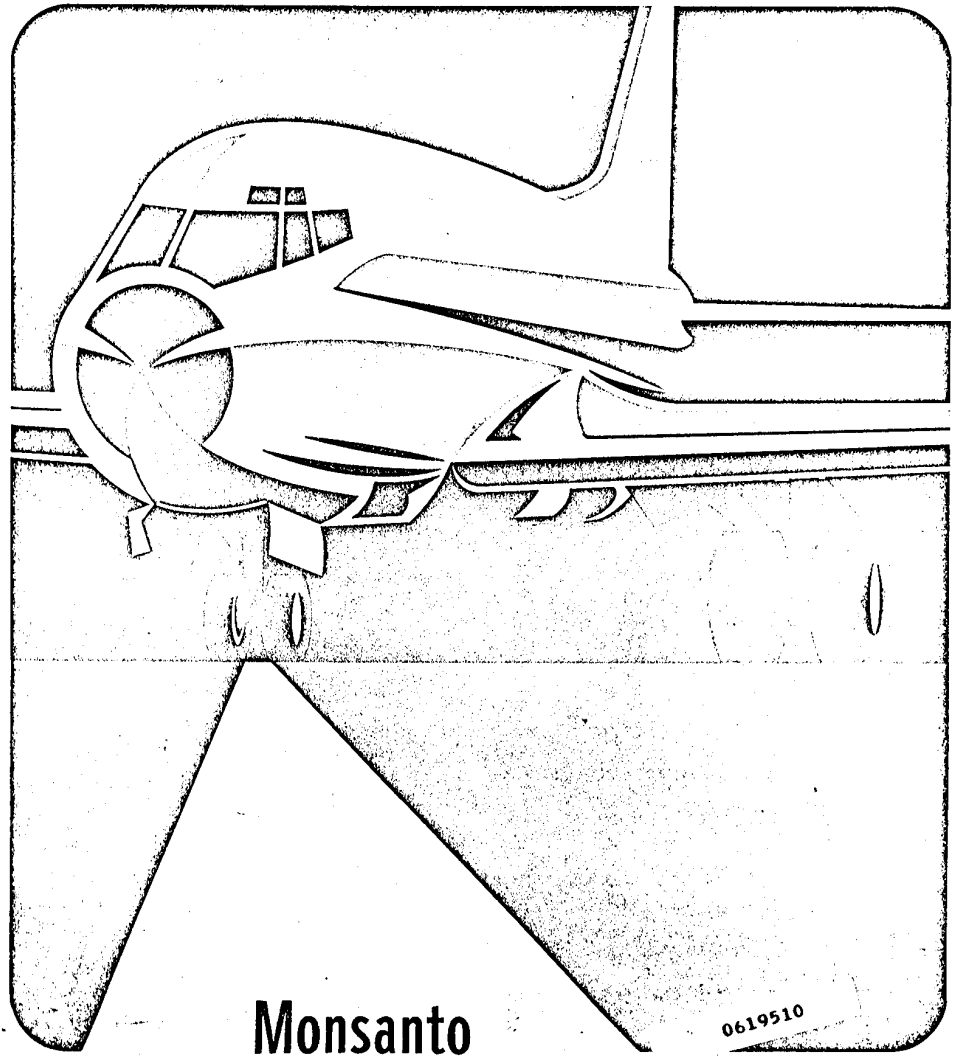
~~Aerospace~~ Fire Resistance Test Methods for ~~Aircraft~~ Hydraulic Fluids

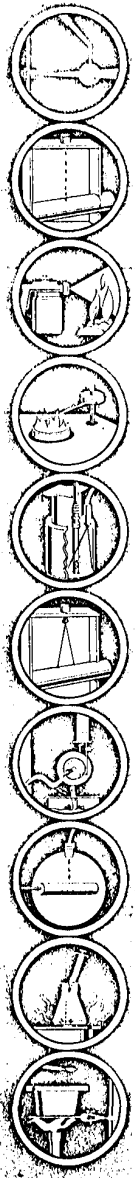
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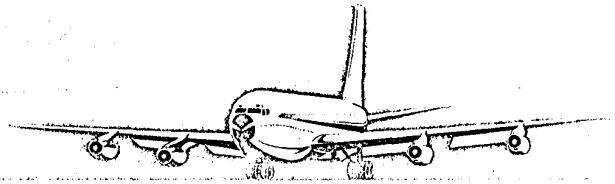


Monsanto

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A Review of Fire Resistance Test Methods for Aircraft Hydraulic Fluids

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Fire-resistant aircraft hydraulic fluids have proven their ability to reduce aircraft fire hazards in the air and on the ground.

Industry trends indicate that all future commercial passenger-carrying aircraft, whether supersonic or subsonic, should use fire-resistant hydraulic fluids to maintain this excellent level of safety.

The definition of fire resistance in precise terms and numbers is extremely difficult and is best done in terms of *expected* fire hazards. Assessment of hazards should include consideration of all three components required for combustion—*fuel*, *oxidizer* and *source of ignition*—as well as ways in which the three can combine into a fire. Such hazards must include all phases of operation; i.e., the supersonic transport will operate part-time supersonic, part-time subsonic and part-time on the ground, and all three conditions must be considered.

Simulative tests are considered most meaningful in assessing fire resistance. Since exposure conditions and sources of ignition vary widely, multiple tests are always required. *Test conditions should reflect two basic parameters of fire resistance—the ability to resist ignition and the ability to carry flame from the source of ignition.* Just as important, the rate at which these combine to cause explosion should be considered.

To be considered for use in the hydraulic system of commercial transports, the hydraulic fluid must be fire-resistant under all operating conditions. The test methods followed by industry today are those spelled out in AMS 3150C. For supersonic operations, the AMS 3150C must be supplemented to include tests simulating conditions aligned to SST operating environments.

The fluid must not change in levels of fire resistance during its use in the aircraft hydraulic system.

Based upon an examination of the probable flammability hazards of subsonic and supersonic aircraft operation, the following tests and performance levels are considered essential for assessing the fire resistance of aircraft hydraulic fluids.

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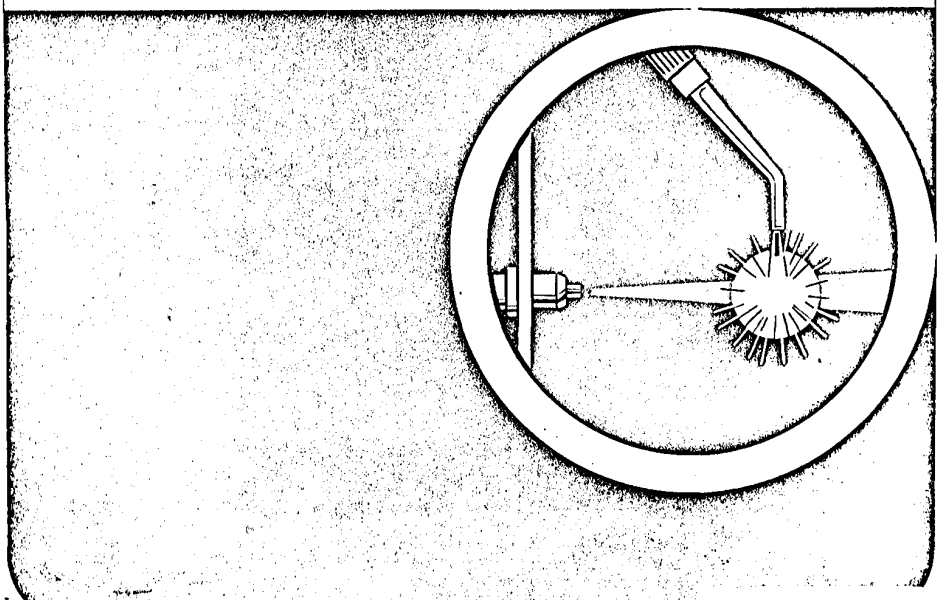
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1

HIGH TEMPERATURE
HIGH PRESSURE SPRAY TEST

Procedure: AMS 3150C. The fluid, at 1000 psi, is sprayed through a 0.0145 in. diameter orifice passing through the flame of an oxyacetylene torch with a No. 1 Purox tip held perpendicular to the fluid stream. Attempts are made to ignite the fluid stream at varying distances from the orifice.

Performance: This test simulates the hazard of a spray from a hydraulic fluid leak coming in contact with a high temperature flame ignition source. ~~Performance should be equivalent to or better than MS-1 Reference Fluid (AMS 3160C).~~ COPY B



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2

HOT MANIFOLD TEST

Procedure: AMS 3150C. Ten milliliters of fluid are dripped in 40 seconds onto a stainless steel simulated hot manifold held at 1300°F. (704°C.). Flashing or burning on contact with the tube, and carrying of flame to fluid collected in the bottom of the shield/ tube holder are observed.

Performance: This test simulates a hydraulic fluid leak coming into contact with a hot surface, ~~such as an engine case, exhaust manifold, hot brake, etc.~~ The hydraulic fluid should show only intermittent flashing when dripped on the 1300°F. (704°C.) manifold and should not carry flame to the bottom of the shield, ~~similar to HS-1 Reference Fluid (AMS 3150C).~~

or burning

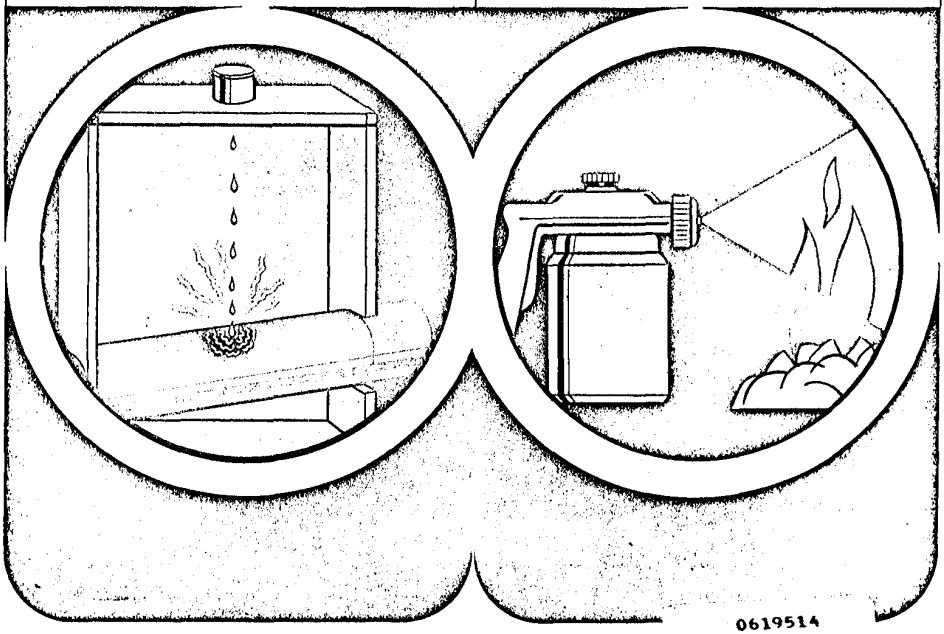
3

LOW PRESSURE SPRAY TEST

Procedure: AMS 3150C. The fluid is sprayed from a Binks Thor No. 7 paint spray gun (0.070 inch diameter orifice, 40 psi air) in bursts over the source of ignition, burning oil-soaked waste. Any increase or decrease in the flame caused by the fluid mist is observed.

~~**Performance:** This test simulates the hazard of a hydraulic fluid spray being swept by the windstream over an open flame source of ignition such as an existing fire. The hydraulic fluid, when sprayed across the source of ignition, should not increase the flame size more than that observed with HS-1 Reference Fluid.~~

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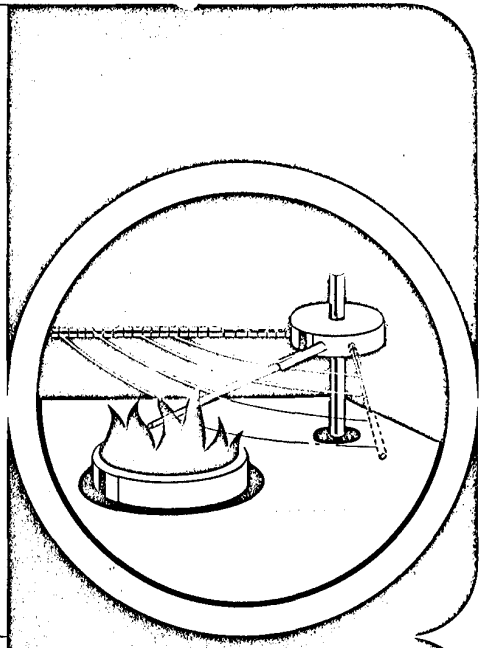
4

WICK FLAMMABILITY TEST

Procedure: AMS 3150C. A pipe cleaner is soaked with fluid and cycled in the horizontal plane into the hottest part of a non-luminous flame of a laboratory burner. The number of cycles required to give a self-sustaining flame is determined.

Performance: This test simulates fluid soaked into absorbent flammable materials and exposed to open flames. ~~Performance should be similar to that observed with HS-1 Reference Fluid (AMS 3150C).~~

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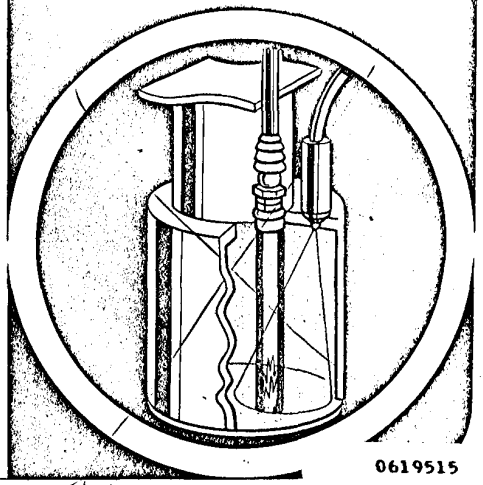
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HOT COMPARTMENT SPRAY TEST (Monsanto)

Procedure: The fluid, at a specified temperature under 1000 psi nitrogen pressure, is sprayed through a 60° spray cone at the rate of one gallon per hour. The fuel nozzle is placed into a heated metal compartment maintained at a specified temperature. This compartment is fitted with 10,000 volt electric arc generating equipment. The heated fluid is sprayed into the compartment with the arc on. Observations are made to determine if the fluid ignites immediately, if pressure rises occur, if the flame is self-sustaining with the arc off, and if the fluid is reignitable. Fluid and compartment temperatures are varied to determine the minimums at which ignition occurs.

Performance: This test simulates a hydraulic fluid leak into an enclosed heated area, such as a wing box, vertical stabilizer or fuselage section, in the presence of a source of ignition such as a spark. The fluid should resist ignition and produce a minimal pressure rise at temperatures representative of maximum heat conditions in flight.



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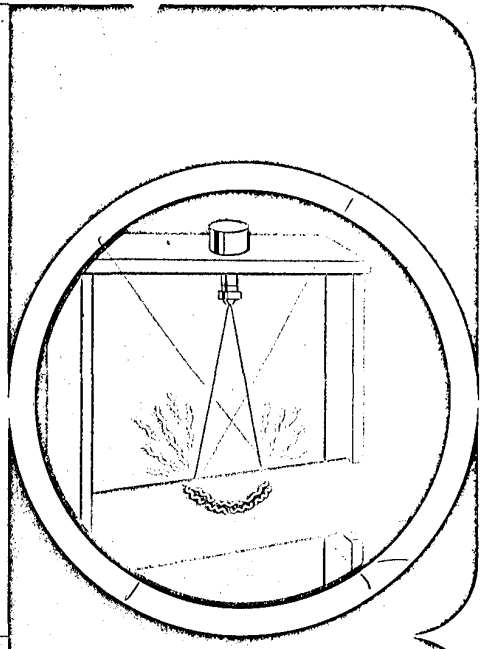
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HOT MANIFOLD SPRAY TEST

Procedure: The hot manifold test apparatus of AMS 3150C is revised to allow spraying of fluid through a 60° spray cone at one gallon per hour. The fuel nozzle, at a specified temperature under 1000 psi pressure is placed on the manifold heated to varying temperatures. The highest manifold temperature (to the nearest 50°F. or 28°C.) at which ignition does not occur is determined.

Performance: This test simulates spraying hot fluid onto a heated metal surface.

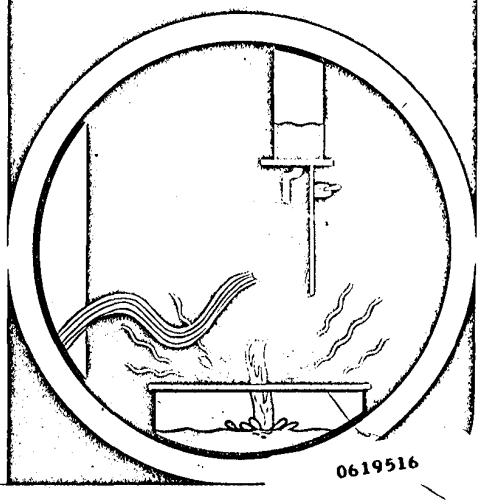


7 This test out completely.

HOT BRAKE FLAMMABILITY TEST
(Graviner, Ltd., Colnbrook, Eng.)

Procedure: The fluid is introduced into an aircraft brake unit modified so that it can be heated internally by electric heaters. The fluid is poured into the interior of the brake assembly through an opening in the wheel rim. Burning characteristics on contact with the heated brake and the fluid's flame-propagating characteristics as it runs out of the brake are determined.

Performance: This test simulates a hydraulic fluid leak onto a hot aircraft brake. The fluid should resist ignition at the expected internal brake temperatures and at various fluid flow rates. It should not carry the flame from the brake.



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8

this Test out completely.

SPONTANEOUS IGNITION TEMPERATURE
(Royal Aircraft Establishment, Farnboro, England)

Procedure: ASTM Publication No. STP 406, p. 44. The fluid is dropped onto a heated pipe contained in a heated sphere. Both temperatures are varied independently to establish spontaneous ignition boundaries. Ignition is determined by pressure rise in the sphere.

Performance: This test simulates ignition by hot surfaces of fluids and vapors contained in a heated compartment.

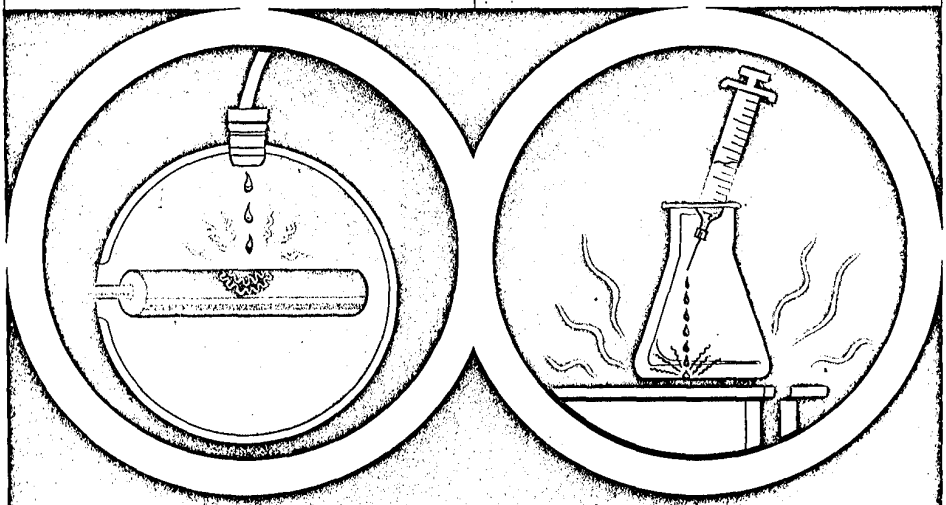
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AUTOIGNITION TEMPERATURE (AIT)

Procedure: ASTM D 2155-66. A fluid sample is injected via hypodermic syringe into a heated glass flask. Autoignition is determined by appearance of visible flame.

Performance: This test measures autogenous ignition temperature in glass in air at one atmosphere pressure. Test conditions are critical and application of data to metal systems of irregular design is difficult. However, it is thought that the AIT should be above the highest compartment temperature expected.



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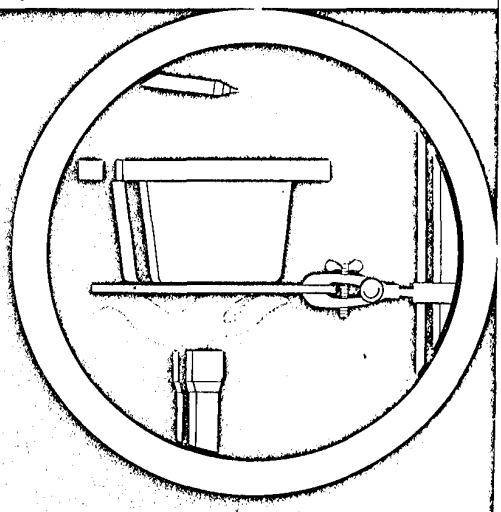
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FLASH AND FIRE POINTS

Procedure: ASTM D 92-66. The fluid is heated in an open test cup at a constant rate. A small test flame is passed over the surface at specified temperature intervals. The lowest temperature at which the vapors above the surface ignite is the flash point. The fire point is the temperature at which the fluid ignites and burns for at least five seconds.

Performance: This test measures the ignitability of heated fluid. Flash and fire test results are sometimes misleading since they are so directly related to the chemical nature of the product being tested.



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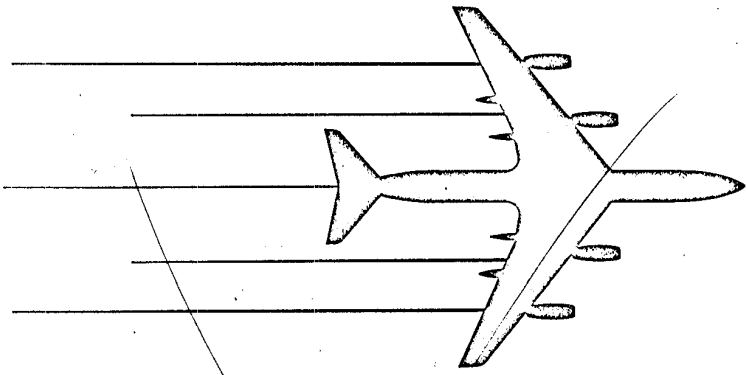
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The test procedures listed here are thought to cover the broad range of flammability hazards expected from aircraft hydraulic system operation. Conditions for each test should be similar to those expected in actual aircraft operation to give appropriate performance levels for each type aircraft. For example, subsonic aircraft experience with fluids that show compliance with AMS 3150C flammability requirements gives a high degree of fire safety. Supersonic aircraft hydraulic fluids should pass these same tests as well as the other tests listed which primarily simulate supersonic hazards. Refinement of methods of hazard analysis and development of test techniques simulating aircraft operational parameters to an even greater extent is expected and should result in improved ways to assess fire resistance and to provide even greater safety in future aircraft.

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COPY H



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