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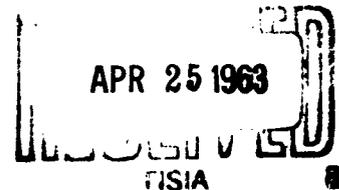
Report No. 8926-147

Material - Adhesives - Structural - EC 1660 and AF-32
(Minnesota Mining and Manufacturing Co.)

Skydrol 500 Hydraulic Fluid Resistance

A. F. Hooper, J. C. George, E. E. Keller

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Abstract:

Tensile shear test specimens made from clad 2024-T3 aluminum alloy sheet in accordance with Specification Mil-A-5059B were bonded with EC 1660 primer and AF-32 adhesive tape. The primer pre-cure was done at 250°F for 30 minutes and the bond was effected by curing the joints at 350°F for 60 minutes under a pressure of 100 psi. Peel test specimens made from 0.020 inch thick by 1.00 inch wide 2024-T3 clad aluminum alloy also were fabricated with the above adhesives and bonding processes. Half of the specimens were immersed in Skydrol 500 hydraulic fluid (Monsanto Chemical Co.) for periods of up to 30 days and the remainder were stored under ambient conditions for comparison purposes. Tensile shear and peel test made after 1, 5, 10, 15, 25 and 30 days showed that the Skydrol 500 hydraulic fluid exerted no significant adverse influence on bond strengths.

Reference: Hooper, A. F., George, J. C., Keller, E. E.,
"Skydrol 500 Hydraulic Fluid Resistance of the
EC 1660 Adhesive Prime & AF-32 Adhesive Bonded
Joints," General Dynamics/Convair Report
MP 58-465, San Diego, California, 11 February
1959. (Reference attached).

ACCESS NO.

Title: MATERIAL - ADHESIVES - STRUCTURAL - EC 1660 and AF 32 (MINNESOTA MINING AND MANUFACTURING CO.). SKYDROL 500 HYDRAULIC FLUID RESISTANCE.

Authors: Hooper, A. F., George, J. C., Keller, E. E.

Report No.: 8926-147

Date: 11 February 1959

Contract: Model 22, Commercial

Contractor: General Dynamics/Convair

ABSTRACT: Tensile shear test specimens made from clad 2024-T3 aluminum alloy sheet in accordance with Specification Mil-A-5059B were bonded with EC 1660 primer and AF 32 adhesive tape. The primer pre-cure was done at 250°F for 30 minutes and the bond was effected by curing the joints at 350°F for 60 minutes under a pressure of 100 psi. Peel test specimens made from 0.020 inch thick by 1.00 inch wide 2024-T3 clad aluminum alloy also were fabricated with the above adhesives and bonding processes. Half of the specimens were immersed in Skydrol 500 hydraulic fluid (Monsanto Chemical Co.) for periods of up to 30 days and the remainder were stored under ambient conditions for comparison purposes. Tensile shear and peel tests made after 1, 5, 10, 15, 25 and 30 days showed that the Skydrol 500 hydraulic fluid exerted no significant adverse influence on bond strengths.

4 pages, 2 tables.

ANALYSIS
PREPARED BY
CHECKED BY
REVISED BY

hooper
George/Keller/Sutherland

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PAGE 1
REPORT NO. MP 58-465
MODEL 22
DATE 2-11-59

INTRODUCTION:

Skydrol 500 hydraulic fluid, a phosphate ester fluid, has a high solvency power on many organic materials. Therefore, Engineering Design requested that test work be performed to determine the Skydrol 500 hydraulic fluid resistance of the AF 32 adhesive bonding system.

OBJECT:

To determine the Skydrol 500 hydraulic fluid resistance of the AF 32 adhesive bonded joints at ambient temperature.

CONCLUSION:

Skydrol 500 hydraulic fluid had no significant deleterious effects on the tensile shear and peel strength of the AF 32 adhesive bonded joints after 30 days immersion at ambient temperature.

TEST SPECIMENS:

Fifty-six (56) tensile shear test specimens were prepared in accordance with Convair Specification 22-00407, paragraph 3.5.1, using the AF 32 adhesive bonding system. Surfaces to be bonded were primed with EC1660.

Twenty-eight (28) peel strength test specimens were prepared in accordance with Convair Specification 22-00407, paragraph 3.5.1, using AF 32 adhesive bonding system. Surfaces to be bonded were primed with EC1660.

TEST PROCEDURE:

Twenty-eight (28) of the fifty-six (56) tensile shear test specimens were immersed in Skydrol 500 hydraulic fluid at ambient temperature. These tensile shear specimens were removed from Skydrol 500 hydraulic fluid in groups of four (4) after immersion. A group of specimens was removed from Skydrol 500 after 1, 5, 10, 15, 20, 25, and 30 day (s) and tested for tensile shear strength at ambient temperature. Duplicate groups of control specimens, which were not immersed, were also tested at 1, 5, 10, 15, 20, 25, and 30 day (s) with the immersed specimens.

Fourteen (14) of the twenty-eight (28) peel strength specimens were immersed in Skydrol 500 hydraulic fluid. These peel strength specimens were removed from Skydrol 500 hydraulic fluid in groups of two (2) after immersion. A group of specimens was removed after 1, 5, 10, 15, 20, 25, and 30 day (s) and tested for peel strength at ambient temperature. The peel strength of duplicate groups of controls, which were not immersed, were tested at 1, 5, 10, 15, 20, 25, and 30 day (s) with the immersed specimens.

ANALYSIS
PREPARED BY Hooper
CHECKED BY George/Keller/Sutherland
REVISED BY

CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION
SAN DIEGO

PAGE 2
REPORT NO. MP 58-465
MODEL 22
DATE 2-11-59

RESULTS:

Skydrol 500 hydraulic fluid moderately softened the cured EC 1660 adhesive primer after 24 hours immersion.

The tensile shear and peel strength data for the AF 32 adhesive bonded system are tabulated in Tables I and II, respectively.

Skydrol 500 hydraulic fluid had no significant deleterious effects on the tensile shear and peel strengths of the AF 32 adhesive bonding system after 30 days immersion at ambient temperature. Skydrol 500 hydraulic fluid moderately softened the EC 1660 adhesive primer adjacent to the adhesive bonded joints. No softening of the EC 1660 adhesive primer was observed inside the glue line on bonded joints during the 30 day immersion period. The AF 32 adhesive bonded joints showed no evidence of Skydrol 500 hydraulic fluid penetration. Skydrol 500 hydraulic fluid plasticized the cured AF 32 tape flash after 5 days immersion.

DISCUSSION OF RESULTS:

The plasticization of the AF 32 tape flash could actually aid in dispersing the concentrated shear load away from the edge of the bonded joint. If Skydrol 500 hydraulic fluid had penetrated inside the glue line to any extent, it would have a deleterious effect on the load carrying capacity of the bonded joint. The tensile shear strengths of the test specimens are well above the 2500 psi. minimum values of the AF 32 adhesive bonded joints (MPS 47.16).

The test results indicate that AF 32 adhesive bonding system was not deleteriously affected by Skydrol 500 hydraulic fluid under the conditions tested.

NOTE: The data from which this report was prepared are recorded in Engineering Test Laboratory Data Book No. 984 and 3032.

TABLE I - TENSILE SHEAR STRENGTH DATA (PSI)
 PERIODS OF IMMERSION IN SKYDROL 500

Specimen No.	1 day	5 days	10 days*	15 days*	20 days	25 days	30 days
1	4170	4050	4320	4480	3800	4600	4450
2	4550	4150	4560	4160	3900	4050	4500
3	4500	3800	4640	4240	3850	4500	4300
4	4400	4250	4080	4480	3800	4300	4250
AVERAGE	<u>4405</u>	<u>4062</u>	<u>4400</u>	<u>4340</u>	<u>3835</u>	<u>4362</u>	<u>4375</u>

Control Specimens No.	Not Immersed in Skydrol 500						
1	3900	4200	4160	4400	4400	4500	4250
2	3950	4300	4480	4240	4100	3950	4250
3	4200	4300	4000	4240	3650	3950	4100
4	4400	4300	4160	4320	3750	4200	4050
AVERAGE	<u>4112</u>	<u>4275</u>	<u>4200</u>	<u>4300</u>	<u>3975</u>	<u>4150</u>	<u>4162</u>

* The 10 & 15 days tensile shear data above for the immersed and control specimens were recalculated upon recalibration of the testing machine which was found to be out of adjustment during testing during those periods.

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4 pages, 2 tables.

TABLE II - PEEL STRENGTH DATA (LBS/INCH WIDTH)

PERIODS OF IMMERSION IN SKYDROL 500

Specimen No.	1 day	5 days	10 days	15 days	20 days	25 days	30 days
1	44	44	48	42	40	40	44
2	44	44	50	40	40	46	40
AVERAGE	<u>44</u>	<u>44</u>	<u>49</u>	<u>41</u>	<u>40</u>	<u>43</u>	<u>42</u>

Not Immersed in Skydrol 500

Control Specimen No.

1	44	42	48	40	44	46	44
2	52	44	50	42	46	44	48
AVERAGE	<u>48</u>	<u>43</u>	<u>49</u>	<u>41</u>	<u>45</u>	<u>45</u>	<u>46</u>