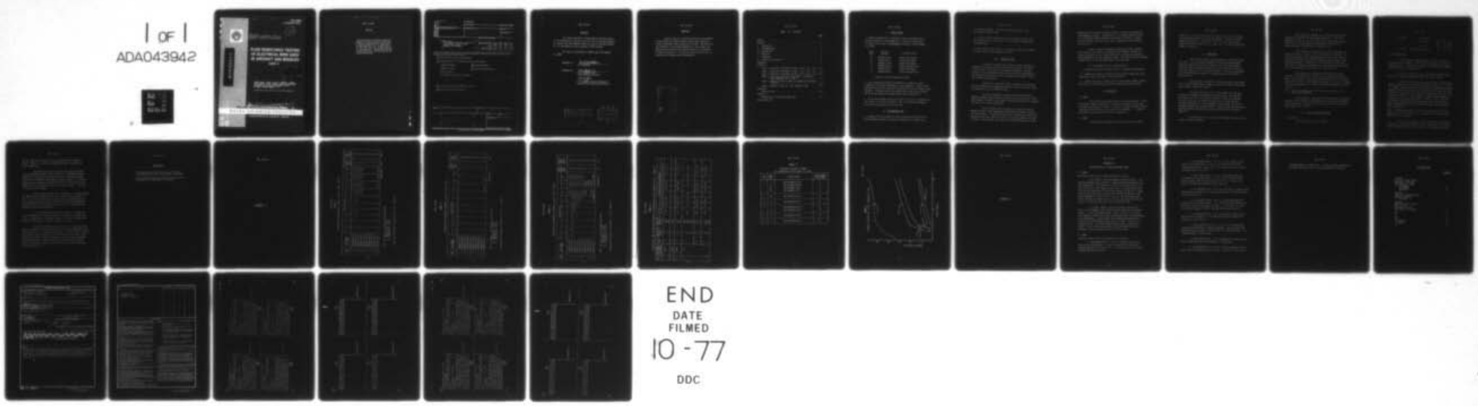
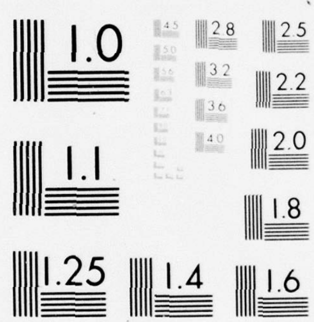
AD-A043 942 NAVAL AVIONICS FACILITY INDIANAPOLIS IND F/G 9/1
FLUID RESISTANCE TESTING OF ELECTRICAL WIRE USED IN AIRCRAFT AN--ETC(U)
AUG 77 W D WATKINS
UNCLASSIFIED NAFI-TR-2199 NL

1 OF 1
ADA043942



END
DATE
FILMED
10-77
DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TR 2199
11 AUGUST 1977

(10)

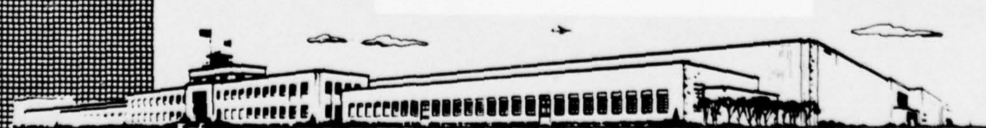
NAFI publication

FLUID RESISTANCE TESTING OF ELECTRICAL WIRE USED IN AIRCRAFT AND MISSILES

PART II

DISTRIBUTION LIMITED TO U.S. GOVERNMENT AGENCIES ONLY: TEST AND EVALUATION. OTHER REQUESTS MUST BE REFERRED TO NAVAL AVIONICS FACILITY, INDIANAPOLIS, INDIANA 46218

DISTRIBUTION UNLIMITED WITH APPENDIX B REMOVED



NAVAL AVIONICS FACILITY
INDIANAPOLIS, INDIANA 46218

NOTICE

DOCUMENT TRANSMITTAL
NAVAIR FORM 3900/3 (REV. 11-72)
S/N 0102-603-3932

CLASSIFICATION UNCLASSIFIED UNCLASSIFIED WHEN ENCLOSURE IS REMOVED	AD NUMBER (*To be inserted by DDC*)	
	ORIGINATING AGENCY Naval Avionics Facility, Indpls, IN	REPORT SERIES AND NUMBER TR-2199
SERIAL NUMBER (*When required*)/DATE	ENCLOSURE (*Report title*) Fluid Resistance Testing of Electrical Wire Used In Aircraft and Missiles (Part II)	REPORT DATE 11 Aug 1977 COG. NAVAIR CODE

TO Administrator
Defense Documentation Center for Scientific and Technical Information (DDC)
Bldg #5, Cameron Station
Alexandria, Virginia 22314

CONTRACT/PROJECT/AIRTASK NUMBER.
Work Request No. 68E95

SECURITY CLASSIFICATION	UNCLAS	CONFI	SECRET	RD
REPORT	X			
TITLE OR SUBJECT	X			
ABSTRACT OR SUMMARY	X			

Enclosure is forwarded for distribution subject to limitations checked below. Please return two copies of this letter to the originating activity shown at the bottom of the page.

- [X] Approved for public release; distribution unlimited. with Appendix B removed
- [X] Distribution limited to U. S. Government agencies only; (check reason below)
  - [ ] Foreign Information
  - [ ] Proprietary Information
  - [X] Test and Evaluation
  - [ ] Contractor Performance Evaluation

Date statement applied:

Other requests for this document must be referred to:

Naval Avionics Facility
Indianapolis, IN 46218

(10 copies with Appendix B removed)

(2 copies with Appendix B)

- [ ] Contractor's limited rights data (ASPR Section IX, Part 2)
- [ ] Controlled by security classification only.

SIGNATURE: L. K. McKinley (ep)

TITLE: Section Supervisor

Commanding Officer
Naval Avionics Facility (Code 915.4)
Indianapolis, IN 46218

CODE

DATE

CLASSIFICATION

UNCLASSIFIED WHEN ENCLOSURE IS REMOVED

PREVIOUS ISSUES OF THIS FORM ARE OBSOLETE.

D-10978

PREFACE

This report describes an investigation into the ability of the insulation on aircraft electrical wire to withstand exposure to cleaners and paint removers which are used on aircraft surfaces. It is a continuation of work reported in NAFI TR-2145[1].

This work was performed for NAVAIR under Work Request No. 68E95.

PREPARED BY: W. D. Watkins
W. D. WATKINS

APPROVED BY: F. H. Gahimer
F. H. GAHIMER, Head
Organic Materials Branch

B. C. Vaughn
B. C. VAUGHN, Director, Materials Laboratory and Consultants Division

(See 1473)

ABSTRACT

Several types of insulated electrical wire purchased to MIL-W-5086, MIL-W-81044 and MIL-W-81381 were immersed in solvents purchased to MIL-C-43616 and TT-R-248. The ability of the insulation to withstand degradation by the solvents was determined by subjecting the conditioned wire to a dielectric withstand voltage test. On some wire types the electrical insulation DC resistance was also determined.

TABLE OF CONTENTS

I. CONCLUSIONS

1. Kapton insulated wire is superior to Poly-X insulated wire in solvent resistance at room temperature. The wires tested herein are ranked in the order of decreasing resistance to solvent damage as follows.

Wire Code	Military Part No.	Insulation Type
16	M81381/17-20-9	Double Wrap Kapton*
14	M81381/7-20-9	Single Wrap Kapton*
11	M81381/11-20-N	Double Wrap Kapton
3	M81044/16-20-9	Double Extruded Poly-X
10	M81381/7-20-N	Single Wrap Kapton
4	M81044/18-20-9	Single Extruded Poly-X

* Topcoat is white fluorocarbon polymer.

2. Kynar jacketed polyalkene insulated wire is superior to nylon jacketed PVC in solvent resistance at room temperature. However, both insulations exhibit low electrical insulation DC resistance after solvent immersion. The Kynar jacketed polyalkene takes longer to be affected and the values observed are higher than on nylon jacketed PVC.

3. The new MIL-C-43616 cleaning fluid (with a pH of 9.2) produced only one failure in all the wires tested. This is a definite improvement over previous types with pH of 11 and over.

II. RECOMMENDATIONS

1. All Navy aircraft currently in service and wired with Poly-X wire to MIL-W-81044/16 through /19 should be inspected on a regular basis

for insulation damage. Particular attention should be given MIL-W-81044/18 and /19 wire.

2. Electrical wire insulated with newly developed polymers should not be used in Navy aircraft until its resistance to solvents has been determined.

3. Only electrical wire which is resistant to solvents and cleaners should be used in high performance aircraft.

III. INTRODUCTION

Electrical wiring in Navy aircraft is often subjected to inadvertent exposure to solvents and chemicals used to clean the aircraft surfaces in the course of maintenance operations. Previous testing[1,2] had indicated that some wire purchased to MIL-W-81044 and MIL-W-81381 were particularly prone to damage by MIL-C-43616 cleaners and TT-R-248 paint removers.

Teflon® (TFE) and Tefzel® (ETFE) insulated wire specified by MIL-W-22759 were not degraded by immersion in any of the test fluids for periods up to and including 28 days.

Stilan® (Polyarylene) insulated wire specified by MIL-W-81044/20 through /29 was shown to be prone to stress cracking or crazing when immersed in alcohol, glycol-water solutions and highly acid solutions. This wire is no longer manufactured.

Poly-X® (Alkane-imide) insulated wire specified by MIL-W-81044/16 through /19 was damaged by highly alkaline cleaning solutions and paint removers. Kapton® (polyimide tape) insulated wire specified by MIL-W-81381 was also shown to be prone to insulation damage by the same solutions. Unfortunately, the time periods used previously to test the wire were such that the investigation did not indicate which would withstand damage the longest. Although Poly-X is no longer available, there is a considerable amount installed in the Navy F-14 aircraft. Kapton wire is currently available and is used in commercial aircraft and the Air Force F-15.

Kynar® jacketed polyalkene insulated wire (often referred to as "Spec 44" wire) which is specified by MIL-W-81044/2 through /15 was not previously tested. Nylon jacketed PVC insulated wire specified by MIL-W-5086 also was not previously tested. The latter wire was previously allowed for use in aircraft wiring but is now prohibited.

It is the purpose of this investigation to:

1. Compare the solvent resistance of Poly-X and Kapton insulated wire.

2. Compare the solvent resistance of Kynar jacketed polyalkane, nylon jacketed PCV and the insulations previously tested.

3. Compare the degree of damage caused by the new MIL-C-43616 cleaning fluid (pH $\leq$ 10) to that caused by high pH cleaners previously tested.

IV MATERIALS

A. FLUIDS

Three fluids were chosen for use in this investigation. Fluid A (MIL-C-43616 cleaner) and Fluid G (TT-R-248 paint remover) are the same as Fluids A and G used in TR-2145[1]. Fluid N is a new MIL-C-43616B cleaning fluid with a pH less than 10 in accordance with Amendment 2. A complete description of the fluids used is given in Appendix C.

B. WIRES

Ten different insulated wires were used. Wires with code numbers 3, 4, 10, 11, 14 and 16 are the same as those used in TR-2145[1] and identified therein by the same code numbers. Four new wires were added; wire codes I, II, III and IV. The wires are listed by code number and military specification in Tables 1-3. A complete description appears in Appendix C.

V. PROCEDURE

The fluids were used in the concentrated "straight from the can" form. This is the usual procedure for using the paint removers. While the cleaning solutions are sometimes used in the concentrated condition, they are usually diluted for use. Specifications requiring pH to be measured use a 1:4 dilution with water. For this investigation, pH of the solutions was measured in concentrated,1:4 dilution and 1.9 dilution form.

Three specimens from each of the ten wire samples were tested in each of the three fluids for immersion times of 1 though 7 consecutive days, 2 weeks, 3 weeks and 4 weeks.

The wire samples were cut to 2 foot lengths with the ends stripped on an automatic Eubanks wire cutting machine. The specimens were formed from the 2 foot lengths by making a single turn loop with the ends of the wire run through the loop twice to secure the loop. The loop was formed to a 1 inch diameter on a rod of that size and the stripped conductor ends twisted together. Identification tags were placed upon each specimen indicating the wire and fluid code and the time of immersion.

All specimens (#1, #2, and #3) were immersed in the test fluid in the "as looped" condition.

After immersion, specimen #1 was rinsed in tap water and allowed to dry one hour at room ambient conditions. It was then immersed for 1 hour in tap water containing an anionic wetting agent. While still in the tap water the insulation was subjected to a 1 minute dielectric withstand test of 2500 volts rms.

After immersion, specimen #2 was rinsed in tap water, uncoiled and allowed to dry for 1 hour at room ambient conditions. It was then subjected to the "double reverse wrap" on a 0.125" diameter mandrel as specified in the solvent resistance test procedure of the wire specifications. Following this, the specimen was formed into a loose coil and immersed in tap water for 1 hour before being subjected to a 1 minute dielectric withstand test of 2500 volts rms.

After immersion, specimen #3 was rinsed in tap water, uncoiled, and allowed to dry for 24 hours at room ambient conditions. Next, it was subjected to the "double reverse wrap" on a 0.125" mandrel, formed into loose coil, and immersed in tap water for 1 hour. The insulation was then subjected to a 1 minute dielectric withstand test of 2500 volts rms.

Note: The mandrel diameter was 0.250" for wire code IV due to its large finished diameter.

During dielectric withstand testing some specimens exhibited excessive current leakage but maintained the voltage without breakdown. These specimens were subjected to insulation resistance testing using 500 VDC applied for 1 minute.

VI. RESULTS AND DISCUSSION

A. pH TESTING

The pH of the fluids was as follows:

Fluid Code	Specification	pH		
A	MIL-C-43616	Conc.	1:4	1:9
		13.3	11.9	11.6
G	TT-R-248	11.6	11.2	11.0
N (New)	MIL-C-43616B, Amend. #2	9.2	9.2	9.1

B. FLUID IMMERSION

The dielectric withstand failures are shown in Tables 1-3 for each period of immersion. Also shown are the values of electrical resistance (in M Ω - 1000 ft.) of specimens exhibiting current leakage during the dielectric withstand test.

Electrical resistance values of the wire insulation after drying and subsequent immersion in water are shown in Table 4.

There were no dielectric withstand failures of either Kynar jacketed polyalkene or nylon jacked PVC wire (wire codes I, II, III and IV). However several of these wires exhibited low insulation resistance. Subsequent drying restored some of the electrical resistance, but upon reimmersion in water the values again were lowered (see Table 4). "Low insulation resistance" for the purposes of reporting was arbitrarily chosen to be those values below 500 M Ω - 1000 ft. This is at least one order of magnitude less than the specification requirement for Kynar jacketed polyalkene but an order higher than that specified for nylon jacketed PVC.

Note: Finished cable harnesses before installation into an aircraft generally must provide 100 M Ω (min.) between one wire and all others electrically tied together.

Fluid G (paint remover) lowered the electrical resistance of both Kynar jacketed polyalkene and nylon jacketed PVC. Both fluids A and N lowered the electrical resistance of nylon jacketed PVC, but did not lower the resistance of Kynar jacketed polyalkene below 500 MΩ - 1000 ft. Thus, Kynar jacketed polyalkene is superior to nylon jacketed PVC.

Two methods of analyzing the data were used to rank the solvent resistance characteristics of the wire. One method involves summing up all dielectric withstand failures for each wire and then ranking them according to that number, as shown in Table 5. The other method involves computing the percent failures for each wire for each immersion time and plotting the results as shown in Graph 1. The rank is the same in both methods.

Graph 1 gives some additional information. The curves should be shaped like those shown for wire codes 4 and 10, but wire code 3 is not. The initial failures of wire code 3 (double extruded Poly-X) in Fluid G were probably caused by a combination of alkali and methylene chloride, while the later failures were due to alkali alone (after the methylene chloride had evaporated).

It is concluded that double extruded Poly-X is superior to single extruded Poly-X. Double wrap Kapton is superior to single wrap Kapton. Kapton with a fluorocarbon topcoat is superior to Kapton with a modified imide topcoat. Kapton is superior to Poly-X.

The new MIL-C-43616 cleaner with a pH of 9.2 caused only one dielectric withstand failure and that was on single extruded Poly-X after 28 days immersion. It lowered the insulation resistance of nylon jacketed PVC but had no effect on the electrical resistance of any other. Since Kapton wire and Kynar jacketed polyalkene wire are the only wire types currently available (of those tested herein) and since MIL-C-43616B Amend. #2 fluid has no adverse effect on them, both of these wire types look promising for use.

REFERENCES

[1] "Fluid Resistance Testing of Electrical Wire Used in Aircraft and Missiles", NAFI TR-2145, 11 Aug 1976

[2] "Fluid Immersion Testing of Aircraft Electrical Wire", Report No. 03-76, NARF-NORIS, 13 Feb 1976

APPENDIX A

TABLE 1.

DIELECTRIC WITHSTAND FAILURES, FLUID A (pH = 13.3)

WIRE CODE	MILITARY PART NUMBER	DAYS OF TEST										TOTAL NO. OF FAILURES	NO. OF SPECIMENS TESTED
		1	2	3	4	5	6	7	14	21	28		
3	M81044/16-20-9			3	2	1		1,2,3	1,2,3	1,2,3	1,2,3	15	30
4	M81044/18-20-9	1	3	2	2,3	2	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	21	30
10	M81381/7-20-N							1,2,3	1,2,3	1,2,3	1,2,3	12	30
11	M81381/11-20-N							1,2,3	1,2,3	1,2,3	1,2,3	12	30
14	M81381/7-20-9											0	30
16	M81381/11-20-9											0	30
I	M81044/12-20-5											0	30
II	M81044/12-20-6											0	30
III	M81044/2-20-9											0	30
IV	M5086/2-18-9								31.7*	26.9*	14.6*	0	30
											Grand Total	= 60	300

Note: No entry: All three specimens passed.
1: Specimen No. 1 fails
2: Specimen No. 2 fails
3: Specimen No. 3 fails

* Insulation resistance of Specimen No. 1 (M Ω - 1000 ft.).

TABLE 2.

DIELECTRIC WITHSTAND FAILURES, FLUID N (pH = 9.2)

WIRE CODE	MILITARY PART NUMBER	DAYS OF TEST										TOTAL NO. OF FAIL-URES	NO. OF SPECI-MENS TESTED
		1	2	3	4	5	6	7	14	21	28		
3	M81044/16-20-9											0	30
4	M81044/18-20-9										2	1	30
10	M81381/7-20-N											0	30
11	M81381/11-20-N											0	30
14	M81381/7-20-9											0	30
16	M81381/11-20-9											0	30
I	M81044/12-20-5											0	30
II	M81044/12-20-6											0	30
III	M81044/2-20-9											0	30
IV	M5086/2-18-9								13.9*	111*		0	30
											Grand Total =	1	300

Note: No entry: All three specimens passed.
1: Specimen No. 1 fails
2: Specimen No. 2 fails
3: Specimen No. 3 fails

* Insulation resistance of Specimen No. 1 (M Ω - 1000 ft.).

TABLE 3.

DIELECTRIC WITHSTAND FAILURES, FLUID G (pH = 11.6)

WIRE CODE	MILITARY PART NUMBER	DAYS OF TEST										TOTAL NO.OF FAIL-URES	NO.OF SPECI-MENS TESTED
		1	2	3	4	5	6	7	14	21	28		
3	M81044/16-20-9	2	3				3		1,2,3	1,2,3	1,2,3	12	30
4	M81044/18-20-9	1,2	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	29	30
10	M81381/7-20-N				3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	19	30
11	M81381/11-20-N				2		2,3	1,2,3	1,2,3	1,2,3	1,2,3	15	30
14	M81381/7-20-9							1,2,3	1,2,3	1,2,3	1,2,3	12	30
16	M81381/11-20-9							2	1,2,3	1,2,3	1,2,3	10	30
I	M81044/12-20-5								0.356*	0.689*		0	30
II	M81044/12-20-6									0.689*		0	30
III	M81044/2-20-9								0.275*	0.168*		0	30
IV	M5086/2-18-9							0.395*	0.010*	0.372*	0.006*	0	30
										Grand Total	=	97	330

Note: No entry: All three specimens passed.
1: Specimen No. 1 fails
2: Specimen No. 2 fails
3: Specimen No. 3 fails

* Insulation resistance of Specimen No. 1 (M Ω - 1000 ft.).

TABLE 4.

ELECTRICAL INSULATION RESISTANCE OF SPECIMEN #1 AFTER IMMERSION (MΩ - 1000 FT)

WIRE NO.	INSULATION RESISTANCE REQUIREMENT	FLUID NO.	DAYS OF IMMERSION IN FLUID	AFTER IMMERSION IN FLUID	PLUS 5 DAY DRY	SUBSEQUENT WATER IMMERSION							
						1 hr.	2 hr.	3 hr.	4 hr.	5 hr.	6 hr.	24 hr.	48 hr.
I	5,000	G	14	.356	8.39	7.52	7.12	-	7.12	7.40	-	18.6	51.3
			21	.689									
II	5,000	G	21	.689									
III	10,000	G	14	.275	4.51	4.00	3.80	-	3.60	3.56	-	4.31	5.15
			21	.168									
IV	40	G	7	.396									
			14	.010	25.3	22.1	14.2	15.7	-	11.9	11.6	11.3	19.6
			21	.372									
			28	.006									
		N	14	13.9	206	202	190	-	182	162	-	131	127
			21	111									
		A	14	31.7	57.0	57.0	49.1	-	45.9	40.8	-	43.5	45.1
			21	26.9									
			28	14.6									

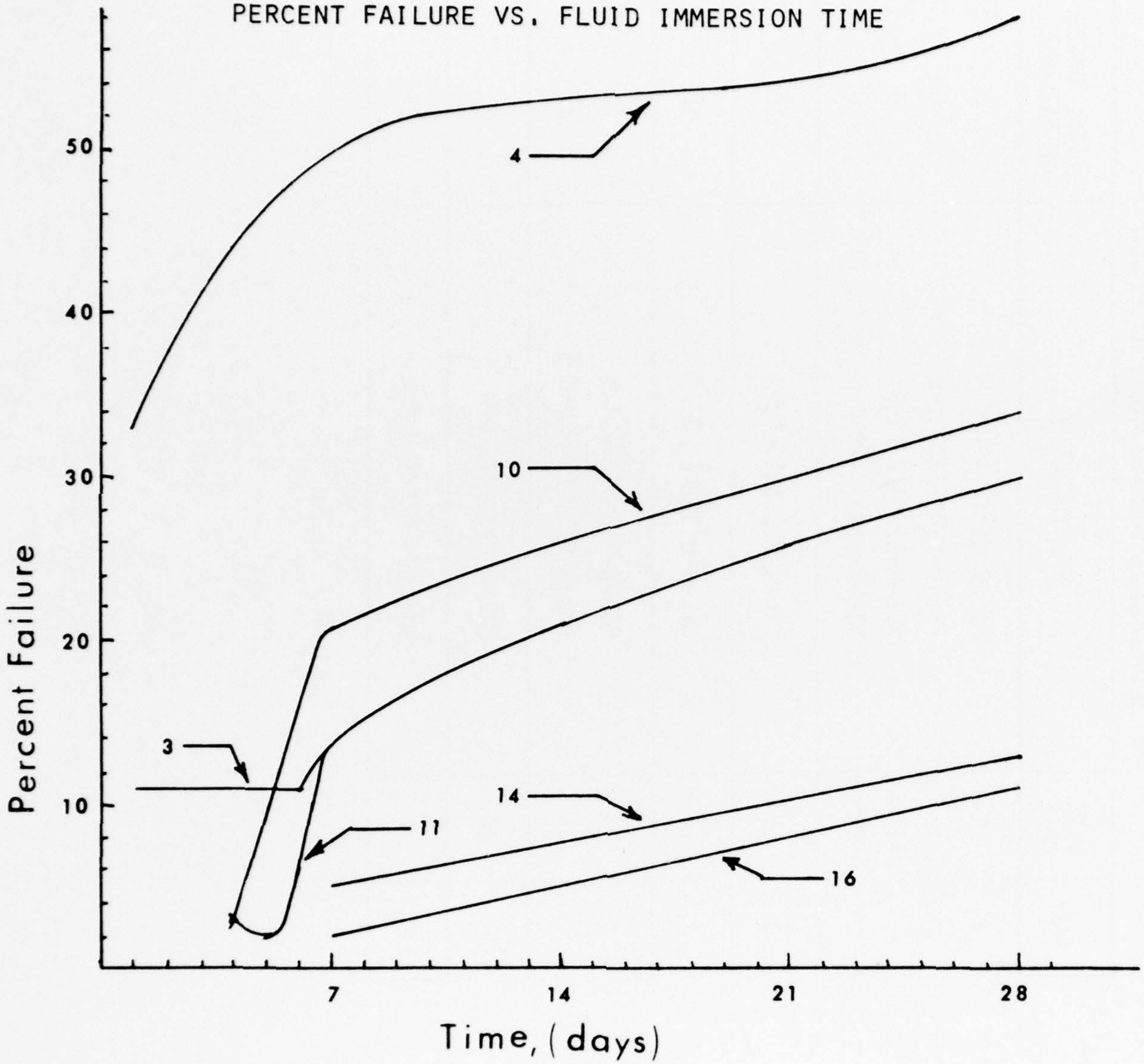
TABLE 5.

RANKING OF WIRE IN ORDER OF DECREASING RESISTANCE TO FLUID

RANK	WIRE CODE	SPECIFICATION	TOTAL NUMBER OF FAILURES
1	I	MIL-W-81044/12-20-5	0
	II	MIL-W-81044/12-20-6	0
	III	MIL-W-81044/2-20-9	0
	IV	MIL-W-5086/2-18-9	0
2	16	MIL-W-81381/11-20-9	10
3	14	MIL-W-81381/7-20-9	12
4	3	MIL-W-81044/16-20-9	27
	11	MIL-W-81381/11-20-N	27
5	10	MIL-W-81381/7-20-N	31
6	4	MIL-W-81044/18-20-9	51

GRAPH 1.

PERCENT FAILURE VS. FLUID IMMERSION TIME



APPENDIX C

APPENDIX C.

DESCRIPTION OF FLUIDS AND WIRES USED

A. FLUIDS

The fluids chosen for this investigation are as follows:

1. MIL-C-43616, "Cleaning Compound, Aircraft Surface". This cleaning compound used by the Navy is water rinsable and required to be 90% biodegradable. The flash point is 142^{o}F (min) and the pH of a 1:4 water dilution must fall between 8.0 and 12.0. The specification does not limit the composition of the cleaner; however, it does list a comparison formula with which to compare the cleaning effectiveness, and a recent amendment (2) limits the pH to 10 max. Two fluids were used: Fluid A (previously tested) with a pH of 13.3, and a new fluid (N) with a pH of 9.2 (both pH's measured in the concentrated form).

2. TT-R-248, "Remover, Paint and Lacquer, Solvent Type". This is a non-flammable, water rinsable solvent type paint and lacquer remover. It must not contain phenol, cresol, creosote oil, cresylic acid, benzene, carbon tetrachloride, perchloroethylene, trichloroethylene, or dichlorethylene. It may contain other chlorinated hydrocarbons if shown to have no deleterious effect on the aircraft. There is no requirement for pH. The specification does not contain a comparison formula. Fluid G (previously tested), containing methylene chloride and having a pH in concentrated form of 11.6, was used.

B. WIRES

The wires chosen for this investigation are as follows:

1. MIL-W-81044/16-20-9. This is a double extruded alkane-imide with an imide topcoat. It has a tin coated 19 strand copper conductor (AWG 20) and is white (-9). This wire was tested in TR-2145[1] and identified by wire code #3.

2. MIL-W-81044/18-20-9. This is a single extruded alkane-imide with an imide topcoat. It has a tin coated 19 strand copper conductor (AWG 20) and is white (-9). This wire was tested in TR-2145[1] and identified by wire code #4.

3. MIL-W-81281/7-20-N. This is a fluorocarbon/polyimide insulated wire with imide topcoat. It has a silver coated 19 strand copper conductor (AWG 20) and is natural color (-N). This wire was tested in TR-2145[1] and identified by wire code #10.

4. MIL-W-81381/7-20-9. This wire is the same as 3 above except that the color is white (-9). This wire was tested in TR-2145 and identified by wire code #14.

5. MIL-W-81381/11-20-N. This is a fluorocarbon/polyimide insulated wire with imide topcoat. It is the same as MIL-W-81381/7-20-N wire except that the insulation is thicker. It is natural (-N) color. This wire was tested in TR-2145[1] and identified by wire code #11.

6. MIL-W-81381/11-20-9. This is the same as 5 above except that the color is white (-9). This wire was tested in TR-2145[1] and identified by wire code #16.

7. MIL-W-81044/12-20-5 and -6. This is a crosslinked polyvinylidene flouride (Kynar) jacketed polyalkene. Two colors were used because they were available. This wire was not previously tested. The finished diameter is 0.055 inches.

8. MIL-W-81044/2-20-9. This is the same as 7 above except the color is white and the finished diameter is 0.078 inches.

9. MIL-W-5086/2-18-9. This wire is nylon jacketed PVC with a glass fiber braid beneath the nylon jacket. The color is white and the

finished diameter is 0.095 inches. It would have been preferable to test AWG 20 but AWG 18 was all that was immediately available.

DISTRIBUTION

	COPIES
Commander Naval Air Systems Command Department of the Navy Washington, D.C. 20361	
AIR-533D1B	1
AIR-533D1B2	1
AIR-52032C	10
Commander Naval Air Engineering Center Lakehurst, NJ 08733	
ESSD-9322	1
Commander Naval Air Rework Facility North Island San Diego, CA 92135 Attn: Mr. S. A. Springer	1
DDC	16
700	1
710	1
713 Gahimer	1
Watkins	1
750	2

Security Classification

DOCUMENT CONTROL DATA - R&D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)
Naval Avionics Facility
Indianapolis, Indiana 46218

2a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

2b. GROUP

3. REPORT TITLE
Fluid Resistance Testing of Electrical Wire Used in Aircraft and Missiles. PART II.

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)
Technical Report - 11 August 1977

5. AUTHOR(S) (Last name, first name, initial)
Watkins, Willard D.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
11 August 1977	26	2

8a. CONTRACT OR GRANT NO.
NAVAIR Work Request No. 68E95

b. PROJECT NO.

c.

d.

9a. ORIGINATOR'S REPORT NUMBER(S)
NAFI-TR-2199

9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

10. AVAILABILITY/LIMITATION NOTICES
Distribution Limited to U.S. Government Agencies Only; Test and Evaluation, Other Requests Must Be Referred To Naval Avionics Facility, Indianapolis, Indiana 46218 DISTRIBUTION UNLIMITED WITH APPENDIX B REMOVED.

11. SUPPLEMENTARY NOTES

12. SPONSORING MILITARY ACTIVITY

13. ABSTRACT

Several types of insulated electrical wire purchased to MIL-W-5086, MIL-W-81044 and MIL-W-81381 were immersed in solvents purchased to MIL-C-43616 and TT-R-248. The ability of the insulation to withstand degradation by the solvents was determined by subjecting the conditioned wire to a dielectric withstand voltage test. On some wire types the electrical insulation DC resistance was also determined.

DD FORM 1473 1 JAN 64

UNCLASSIFIED
Security Classification

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Insulated Wire Cleaning Fluids Dielectric Withstand						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization *(corporate author)* issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers *(either by the originator or by the sponsor)*, also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those imposed by security classification, using standard statements such as:

(1) "Qualified requesters may obtain copies of this report from DDC."

(2) "Foreign announcement and dissemination of this report by DDC is not authorized."

(3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through
____ ."

(4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through
____ ."

(5) "All distribution of this report is controlled. Qualified DDC users shall request through
____ ."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring *(paying for)* the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as *(TS)*, *(S)*, *(C)*, or *(U)*.

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, roles, and weights is optional.

Security Classification

Naval Avionics Facility (NAFI
Report TR-2199)
FLUID RESISTANCE TESTING OF ELECTRICAL WIRE USED IN AIRCRAFT AND MISSILES PART II.
by W.D.Watkins 11 Aug 1977 26p
UNCLASSIFIED

Several types of insulated electrical wire purchased to MIL-W-5086, MIL-W-81044 and MIL-W-81381 were immersed in solvents purchased to MIL-C-43616 and TT-R-248. The ability of the insulation to withstand degradation by the solvents was determined by subjecting the conditioned wire to a

UNCLASSIFIED

Naval Avionics Facility (NAFI
Report TR-2199)
FLUID RESISTANCE TESTING OF ELECTRICAL WIRE USED IN AIRCRAFT AND MISSILES PART II.
by W.D.Watkins 11 Aug 1977 26p
UNCLASSIFIED

Several types of insulated electrical wire purchased to MIL-W-5086, MIL-W-81044 and MIL-W-81381 were immersed in solvents purchased to MIL-C-43616 and TT-R-248. The ability of the insulation to withstand degradation by the solvents was determined by subjecting the conditioned wire to a

UNCLASSIFIED

Naval Avionics Facility (NAFI
Report TR-2199)
FLUID RESISTANCE TESTING OF ELECTRICAL WIRE USED IN AIRCRAFT AND MISSILES PART II.
BY W.D.Watkins 11 Aug 1977 26p
UNCLASSIFIED

Several types of insulated electrical wire purchased to MIL-W-5086, MIL-W-81044 and MIL-W-81381 were immersed in solvents purchased to MIL-C-43616 and TT-R-248. The ability of the insulation to withstand degradation by the solvents was determined by subjecting the conditioned wire to a

UNCLASSIFIED

Naval Avionics Facility (NAFI
Report TR-2199)
FLUID RESISTANCE TESTING OF ELECTRICAL WIRE USED IN AIRCRAFT AND MISSILES PART II.
by W.D.Watkins 11 Aug 1977 26p
UNCLASSIFIED

Several types of insulated electrical wire purchased to MIL-W-5086, MIL-W-81044 and MIL-W-81381 were immersed in solvents purchased to MIL-C-43616 and TT-R-248. The ability of the insulation to withstand degradation by the solvents was determined by subjecting the conditioned wire to a

dielectric withstand voltage test. On some wire types the electrical insulation DC resistance was also determined.

UNCLASSIFIED

dielectric withstand voltage test. On some wire types the electrical insulation DC resistance was also determined.

UNCLASSIFIED

dielectric withstand voltage test. On some wire types the electrical insulation DC resistance was also determined.

UNCLASSIFIED

dielectric withstand voltage test. On some wire types the electrical insulation DC resistance was also determined.

UNCLASSIFIED

Naval Avionics Facility (NAFI Report TR-2199)
FLUID RESISTANCE TESTING OF ELECTRICAL WIRE USED IN AIRCRAFT AND MISSILES PART II.
by W.D.Watkins 11 Aug 1977 26p
UNCLASSIFIED

Several types of insulated electrical wire purchased to MIL-W-5086, MIL-W-81044 and MIL-W-81381 were immersed in solvents purchased to MIL-C-43616 and TT-R-248. The ability of the insulation to withstand degradation by the solvents was determined by subjecting the conditioned wire to a

UNCLASSIFIED

Naval Avionics Facility (NAFI Report TR-2199)
FLUID RESISTANCE TESTING OF ELECTRICAL WIRE USED IN AIRCRAFT AND MISSILES PART II.
by W.D.Watkins 11 Aug 1977 26p
UNCLASSIFIED
Several types of insulated electrical wire purchased to MIL-W-5086, MIL-W-81044 and MIL-W-81381 were immersed in solvents purchased to MIL-C-43616 and TT-R-248. The ability of the insulation to withstand degradation by the solvents was determined by subjecting the conditioned wire to a
UNCLASSIFIED

Naval Avionics Facility (NAFI Report TR-2199)
FLUID RESISTANCE TESTING OF ELECTRICAL WIRE USED IN AIRCRAFT AND MISSILES PART II.
BY W.D.Watkins 11 Aug 1977 26p
UNCLASSIFIED
Several types of insulated electrical wire purchased to MIL-W-5086, MIL-W-81044 and MIL-W-81381 were immersed in solvents purchased to MIL-C-43616 and TT-R-248. The ability of the insulation to withstand degradation by the solvents was determined by subjecting the conditioned wire to a
UNCLASSIFIED

Naval Avionics Facility (NAFI Report TR-2199)
FLUID RESISTANCE TESTING OF ELECTRICAL WIRE USED IN AIRCRAFT AND MISSILES PART II.
by W.D.Watkins 11 Aug 1977 26p
UNCLASSIFIED
Several types of insulated electrical wire purchased to MIL-W-5086, MIL-W-81044 and MIL-W-81381 were immersed in solvents purchased to MIL-C-43616 and TT-R-248. The ability of the insulation to withstand degradation by the solvents was determined by subjecting the conditioned wire to a

dielectric withstand voltage test. On some wire types the electrical insulation DC resistance was also determined

UNCLASSIFIED

dielectric withstand voltage test. On some wire types the electrical insulation DC resistance was also determined

UNCLASSIFIED

dielectric withstand voltage test. On some wire types the electrical insulation DC resistance was also determined

UNCLASSIFIED

dielectric withstand voltage test. On some wire types the electrical insulation DC resistance was also determined

UNCLASSIFIED