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270 VOLT DC VARIABLE SPEED GENERATOR AND CONTROL UNIT, AIRCRAFT ELECTRICAL POWER SYSTEM

September 18, 1980

FINAL TECHNICAL REPORT

Prepared by:

[illegible]

Prepared for:

Naval Air Development Center
Warminster PA [illegible]

UNCLASSIFIED

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SUMMARY

1. This task included the setup, instrumentation, testing and data compilation for a single generator 270 volt DC (direct current) aircraft electric power system.
2. The generator system was interconnected, instrumentation was completed, and operational tests were conducted. Several deficiencies were observed:
   (a) The generator coolant reservoir was too small to contain the coolant expansion at operating temperatures. This caused coolant loss through the reservoir relief valve. An external expansion tank was added to correct this problem.
   (b) A water cooled heat exchanger did not provide controllable generator coolant temperature. An air cooled exchanger was substituted in the test setup with improved results.
   (c) The generator drive stand speed was limited to 10,500 RPM (revolutions per minute). Repair and adjustment of drive electronics was required to obtain speeds over the range 9,000 to 18,000 RPM.
3. Generator voltage regulation tests over the rated speed and load range disclosed:
   (a) 270 volt DC output voltage was maintained over rated speed and load with momentary application and removal of rated loads.
   (b) Voltage transients exceed specified limits with load application and removal.
   (c) Voltage transient recovery time is within allowable limits for rated load application and removal.
   (d) High ripple voltage developed during tests at 14,000 RPM and remained high during the balance of the voltage regulation tests. The ripple voltage exceeded specified limits - 24 volt P/P (peak to peak). The generator high ripple protection did not trip as required. However, it did trip once during the 17,500 RPM tests and reset when the control switch was cycled.

4. Coolant loss was a continuing operational problem. The addition of an expansion tank helped, but it did not solve the problem. During temperature stability tests, coolant was lost. There was no visible dripping but there was a vapor cloud over the generator. On July 1, coolant started to drip from the front and rear generator flanges.
5. On July 9, after approximately 100 hours of generator operation, the generator developed a ground fault. There was a blow out, with fire, from the rear manifold. The fire extinguished. Heavy vapor then enveloped the generator and coolant was observed flowing at the front and rear flanges. Fire engulfed the generator and was put out with carbon dioxide extinguishers. The fire was extinguished approximately one minute after symptoms of the ground fault were observed on video tape.
6. Subsequent closed cup flash point tests of samples of Coolanol 25 which was drained from the generator coolant system showed that the Coolanol 25 flash point had degraded to room temperature (less than $78^{o}F$). The manufacturers' technical bulletin specifies flash point (minimum) $325^{o}F$.

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INTRODUCTION

1. Background

The Navy is developing an advanced electric power system for future military aircraft. The system consists of the 270 volt DC generator, regulator, protective and distribution system components necessary to implement a complete aircraft system.

The development of the system components is presently under contract to various avionic and airframe contractors. As each component type is delivered, it is necessary that it be subjected to various performance tests to determine if the essential performance requirements and design goals have been met. This information will be used to establish state-of-art tradeoff alternatives for component development and system performance criteria.

2. Scope

This task includes the setup, instrumentation, testing and data compilation for a single generator 270 volt DC electric power system.

3. Task One Effort

This first phase test consisted of completing a partially assembled test setup, conducting preliminary operational tests, and initiating generator voltage regulation tests over the rated speed and load range.

TEST SETUP

1. A wiring diagram of the 270 volt DC system interconnection and instrumentation is shown on Figure 1 (Wiring Diagram, 270 VDC Generator Lab Test, NADC Drawing No. TE22082).

2. Additional instrumentation, not shown on Figure 1, consisted of thermocouple temperature monitoring of coolant temperature into the generator, coolant temperature out of the generator, and one generator bearing temperature. The generator had four thermocouples, but the only one operative was the one from the top of the generator rear manifold cover.

3. Closed circuit television camera monitoring and recording was also provided.

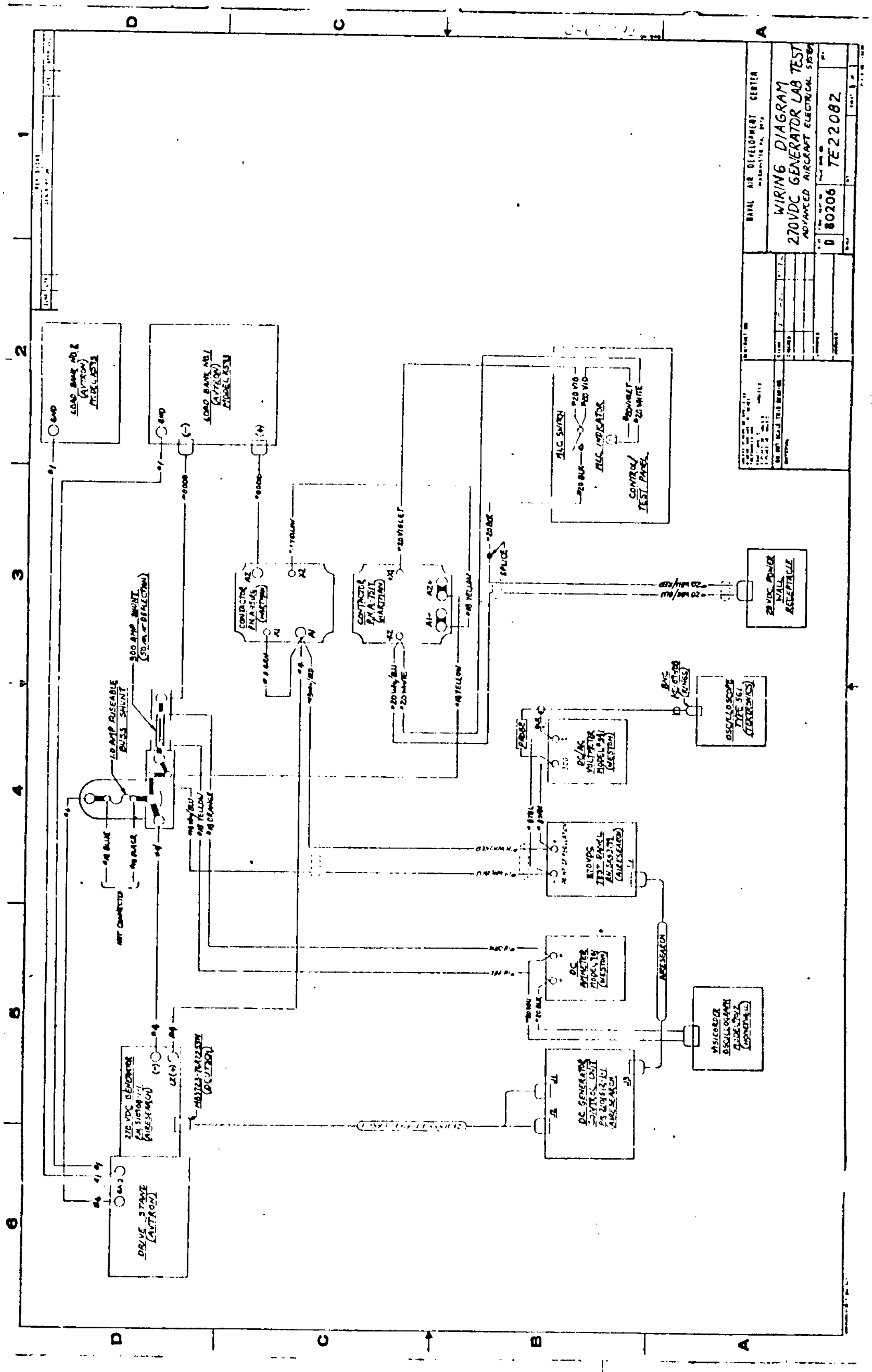
NAVAL AIR DEVELOPMENT CENTER
WIRING DIAGRAM
270VDC GENERATOR LAB TEST
ADVANCED AIRCRAFT ELECTRICAL SYSTEM
80206
TE22082

Figure 1

OPERATIONAL TESTS

1. Prior to start of voltage regulation electrical test, operational tests of the generator were conducted to obtain some baseline data. It was established from discussions at NAVAIRDEVCEN that the maximum coolant temperature should be 80°C at the output of the heat exchanger (the input to the generator) with the generator under full load. Test Data Sheet #1 shows the results of tests wherein waterflow through a heat exchanger was adjusted to establish a maximum temperature of 80°C under full load.

2. The initial test disclosed an operating deficiency wherein the generator coolant system, including the reservoir, could not contain the coolant as it expanded from operational temperature rise. As a result, an expansion tank was added to test setup. Test Data Sheet #2 presents test results with the expansion tank in the setup. An additional operational problem appeared; coolant was lost during operational test although there were no visible signs of loss such as dripping coolant. However, a heavy vapor cloud was visible over the generator during tests.

3. Test Data Sheet #3 presents the data from a test conducted to determine the transient amplitude variations in the 270 volt DC level as the generator control panel three-position switch (OFF-TEST-ON) is switched from OFF to TEST to ON. Transients were recorded on the visicorder (Figure 1) using a fluid damped galvonometer, Type M3300, and matching network.

4. Test Data Sheet #4 presents the data from a test conducted to monitor generator coolant and bearing temperature rise under no load using the water cooled heat exchanger with the water flow set as was required to maintain coolant "in" at 80°C under full load. Since coolant exceeded the 80°C limit with

the exchanger water flow set as it had been to maintain 80°C with full load, it was concluded that the water cooled exchanger did not provide a controlled/stable temperature base line as required for generator tests. The water cooled exchanger was replaced by an air cooled exchanger with improved results.

TEST DATA SHEET
4ND-NADC-3960/12 #1

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	12 JUN 80	1 OF 1
MANUFACTURER		MFR'S MODEL NO.	
AiResearch (Div of Garrett), Torrance, CA		518988-1-1	
TEST Water Cooled Heat Exchanger	SPEC. NO.	TYPE NO.	
PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY
			T. Boyce

DESCRIPTION

Adjust water flow in heat exchanger to maintain generator coolant "in" at approximately 80°C with generator at 9000 RPM and full load.

TIME	SPEED RPM	VOLTS	I AMPS	COOLANT TEMP °C IN	COOLANT TEMP °C OUT	FLOW %	REAR BEARING TEMP °C
1022	9000	269.5	44	34	38	55	-
1025	9000	269.5	80	35	39	55	-
1033	9000	269.5	121	38	44	55	-
1038	9000	269.5	166	42	50	56	-
1046	9000	269.5	166	50	62	56	96
1102	9000	269.5	166	54	67	56	118
1107	9000	269.5	166	44	54	56	105
1120	9000	269.5	166	56	64	56	110
SHUT DOWN							
1254	9000	269.5	166	37	43	54	52
1308	9000	269.5	166	60	71	56	110
1315	9000	269.5	166	73	85	56	120
1328	9000	269.5	166	82	96	54	136
1345	9000	269.5	166	80	-	-	142
1350	9000	269.5	166	82	-	-	145
1400	9000	269.5	166	76	-	-	143
1413	9000	269.5	166	78	-	-	143
1430	COOLANT BUBBLING OUT OF RESERVOIR RELIEF VALVE.						
	SHUT DOWN.						

PLATE NO. 10856

TEST DATA SHEET
4ND-NADC-3960/12 #2

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	13 JUN 80	1 OF 1
MANUFACTURER		MFR'S MODEL NO.	
AiResearch (Div of Garrett), Torrance, CA		518988-1-1	
TEST Water Cooled Heat Exchanger	SPEC. NO.	TYPE NO.	
PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY
			T. Boyce

DESCRIPTION
Added coolant expansion tank. Test systems at full load and 9000 RPM to determine effect of added expansion tank in reduction of operational loss of coolant.

TIME	SPEED RPM	VOLTS	I AMPS	COOLANT TEMP °C IN	COOLANT TEMP °C OUT	FLOW %	REAR BEARING TEMP °C					
1130	9000	269.5	44	-	-	-	-					
1200	9000	269.5	121	60	-	-	88					
1220	9000	269.5	166	-	-	-	-					
1225	9000	269.5	166	78	90	44	112					
1245	9000	269.5	166	77	93	51.5	143					
1300	9000	269.5	166	78	96	48	143					
1300	SHUT DOWN - SPEED TO 2000 RPM											
1315	-	-	-	47	-	-	90					
1322	-	-	-	42	-	-	68					

NOTE: MONDAY, 16 JUN, GENERATOR COOLANT LEVEL WAS BELOW SIGHT GAUGE IN GENERATOR COOLANT RESERVOIR. COOLANT IS BEING LOST DURING OPERATIONAL TEST. THERE IS NO VISIBLE SOURCE OF COOLANT LOSS - NO DRIPPING. HOWEVER, HEAVY VAPOR CLOUDS ARE VISIBLE OVER THE GENERATOR DURING OPERATIONAL TESTS.

PLATE NO. 10856

TEST DATA SHEET
WND-NADC-3960/12 #3

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	20 JUN 80	1 OF 1
MANUFACTURER		MFR'S MODEL NO.	
AiResearch (Div of Garrett), Torrance, CA		518988-1-1	
TEST	SPEC. NO.	TYPE NO.	
Voltage Transients	NADC-VT-TS-7502, 13 JUN 75		
PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY
			T. Boyce

DESCRIPTION
Record 270V DC voltage as generator is switched from OFF to TEST to ON to TEST by means of the generator control panel three-position switch (OFF-TEST-ON).

			COOLANT			REAR	VOLTAGE TRANSIENTS					
							TEST		ON		TEST	
TIME	SPEED RPM	LOAD	TEMP °C IN	OUT	FLOW %	BEAR. TEMP °C	+	-	+	-	+	-
1035	9000	N/L	47	-	55	55	630	-20	580	+80	650	0
1120	9000	N/L	62	67	-	80	660	-20	630	+20	660	0
1320	9000	N/L	42	45	-	-	625	-20	660	0	660	0
1322	9000	N/L	42	45	-	58	660	-20	620	+30	635	0
1325	9000	N/L	52	56	-	65	635	-20	625	+20	655	0
1420	9000	N/L	61	74	-	85	645	-20	580	60	520	20
1504	9000	N/L	78	84	54	95	-	-	-	-	-	-

PLATE NO. 10856

TEST DATA SHEET
4ND-NADC-3960/12 #4

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	23 JUN 80	1 OF 1
MANUFACTURER		MFR'S MODEL NO.	
AiResearch (Div of Garrett), Torrance, CA		518988-1-1	
TEST Temperature Rise 9000 RPM, No Load	SPEC. NO.	TYPE NO.	
PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY T. Boyce

DESCRIPTION
Monitor temperature rise of generator coolant and rear bearing @ 9000 RPM with no load. Water cooled heat exchanger set to maintain 80°C at full load.

TIME	SPEED RPM	LOAD	COOLANT TEMP °C IN	COOLANT TEMP °C OUT	BEARING TEMP °C
0830	9000	N/L	45	49	53
0900	9000	N/L	68	73	83
0930	9000	N/L	75	80	90
1000	9000	N/L	78	84	95
1130	9000	N/L	87	93	100

A WATER-COOLED HEAT EXCHANGER WAS IN USE TO MAINTAIN GENERATOR COOLANT TEMPERATURE WITHIN DESIRED LIMITS. WATER FLOW HAD BEEN ADJUSTED TO MAINTAIN THE GENERATOR COOLANT AT APPROXIMATELY 80°C @ 9000 RPM WITH FULL LOAD. TEST RESULTS ABOVE INDICATE COOLANT TEMPERATURE INTO THE GENERATOR (AFTER HEAT EXCHANGE) TO BE IN EXCESS OF THE DESIRED 80°C UNDER NO LOAD. THE WATER COOLED HEAT EXCHANGER WAS REMOVED FROM THE TEST SETUP AND WAS REPLACED BY AN AIR COOLED HEAT EXCHANGER WITH IMPROVED RESULTS.

PLATE NO. 10856

VOLTAGE REGULATION

1. Test Data Sheet #5 presents data on a voltage regulation test. During this test we observed the first sign of coolant leakage. Coolant was found dripping from both the front and rear generator flanges and voltage transients were observed which exceed the contract referenced specification.

2. Test Data Sheet #6 presents generator RPM, voltage, coolant temperature "in", bearing temperature, and coolant flow during voltage regulation tests. Data is given under no load. It was at the completion of these tests that a 100% load was applied to the generator at 18,000 RPM. The purpose was to observe performance, temperature rise, stability, etc., under continuous load at 18,000 RPM for comparison with test results at 9,000 RPM. Shortly after application of the 100% load, a ground fault occurred. A blow-out was observed in the vicinity of the rear manifold, which ignited and then extinguished. A heavy vapor cloud was expelled by the generator and coolant was then observed flowing heavily from the front and rear flanges. Fire then engulfed the generator and was put out by carbon dioxide extinguishers approximately one minute after symptoms of the ground fault were observed. The sequence of events was recorded on video tape.

3. Test Data Sheet #7 (6 pages) presents results of tests at speeds from 9,000 to 18,000 RPM with momentary loads of 0 to 25%, 0 to 50%, 0 to 75%, and 0 to 100% applied and removed. At a speed of 14,000 RPM a high ripple voltage developed. Since it was above fault limits, 24V P/P for 200 ms, the generator voltage should have, but did not, cut off. Had this fault been observed, as a results of continual voltage cut off, it would have terminated tests and possibly prevented subsequent loss of the generator from the ground fault fire. Test data shows voltage transients in excess of specified limits with recovery time within allowable limits.

TEST DATA SHEET
4ND-NADC-3960/12 #5

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	1 JUL 80	1 OF 1
MANUFACTURER		MFR'S MODEL NO.	
AiResearch (Div of Garrett), Torrance, CA		518988-1-1	
TEST Voltage Regulation and Transients	SPEC. NO. NADC-VT-TS-7502 13 JUN 75	TYPE NO.	
PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY T. Boyce

DESCRIPTION
Test generator voltage regulation at rated speeds with loads of 25, 50, 75 and 100%. Generator was set to desired speed. Momentary loads were applied as follows: 0 to 25%, 0 to 50%, 0 to 75%, and 0 to 100%.

COOLANT BEARING VOLTAGE TRANSIENTS

TIME	SPEED RPM	LOAD %	RECORD NO.	VOLTS	RIPPLE V P/P	TEMP °C IN	FLOW %	TEMP °C	ON LOAD +	ON LOAD -	OFF LOAD +	OFF LOAD -
0945	9000	N/L	-	270	-	41	56	55	-	-	-	-
1035	COOLANT DRIP FROM FRONT AND REAR GENERATOR FLANGES (16 DROP/MIN)											
1210	9000	100	-	-	-	44	-	58				
1216	9000	100	-	-	-	50	-	89	COOLANT DRIP (9 DROP/MIN)			
1250	9000	25	4017	270	15	-	-	-	-	218	320	190
-	9000	50	4021	270	8	-	-	-	-	240	415	207
-	9000	75	4022	270	6	-	-	-	-	230	370	195
-	9000	100	4023	270	5	-	-	-	-	230	360	195
1350	10000	25	4028	270	15	-	-	-	-	215	325	175
	10000	50	4029	270	6	-	-	-	-	210	405	190
	10000	75	4030	270	6	-	-	-	-	185	370	190
	10000	100	4031	270	6	-	-	-	-	235	350	190

NOTE: TRANSIENT VOLTAGE (REF. SPEC) MUST BE WITHIN 350V/200V WINDOW FOR LOAD APPLICATION AND REMOVAL.

DATA ABOVE SHOWS SIX TRANSIENTS ABOVE 350V AND SEVEN BELOW 200V.

PLATE NO. 10856

TEST DATA SHEET
4ND-NADC-3960/12 #6

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	9 JUL 80	1 OF 1

MANUFACTURER	MFR'S MODEL NO.
AiResearch (Div of Garrett), Torrance, CA	518988-1-1

TEST	SPEC. NO.	TYPE NO.
Generator Temperature During Voltage Regulation Tests	13 JUN 75 NADC-VT-TS-7502	

PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY
			T. Boyce

DESCRIPTION

Data presented: Generator RPM, voltage, coolant temperature "in", bearing temperature, coolant flow during test of generator at rated speeds and loads. Data given under no-load condition.

TIME	SPEED RPM	OUTPUT VOLTS	COOLANT TEMP °C IN	BEARING FLOW %	BEARING TEMP °C	
1030	9000	270	42	56	50	
1035	11000	270	44	66	55	
1040	11500	270	44	69	62	
1042	12000	270	45	-	65	
1046	13000	270	46	76	70	
1050	13500	270	46	79	72	
1051	14000	270	47	81	75	
1053	14500	270	47	84	77	
1055	15000	270	48	86	80	
1057	15500	270	49	87	83	
1100	16000	270	49	89	86	
1102	17000	270	51	90	90	
1105	17500	270	52	92	95	
1107	18000	NO VOLT	-	-	-	SWITCH TO OFF THEN TO TEST
1110	17500	270	50	91	95	
1111	18000	270	52	92	97	
*1115	18000	@ 100% LOAD				
1115	-	-	54	92	100	FIRE! EVIDENCE OF GROUND FAULT
	TRIGGERING THE INCIDENT.					

PLATE NO. 10856

TEST DATA SHEET
4ND-NADC-3960/12 #7

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	9 JUL 80	1 OF 6
MANUFACTURER		MFR'S MODEL NO.	
AiResearch (Div of Garrett), Torrance, CA		518988-1-1	
TEST Voltage Regulation and Transients	SPEC. NO. 13 JUN 75 NADC-VT-TS-7502	TYPE NO.	
PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY T. Boyce

DESCRIPTION

Voltage regulation at rated speeds and with loads of 25, 50, 75 and 100%. Generator was set to desired speed. Momentary loads were applied as follows: 0 to 25%, 0 to 50%, 0 to 75%, and 0 to 100%.

VOLTAGE TRANSIENTS RECOVERY TIME

RECORD NUMBER	SPEED RPM	LOAD %	VOLTS	RIPPLE V P/P	ON LOAD +	ON LOAD -	OFF +	OFF -	MILLISEC ON	MILLISEC OFF
4306	9000	N/L	270	1.2	-	-	-	-	-	-
4306	9000	25	270	13.2	-	-	312	208	-	40
4307	9000	50	270	8.5	-	208	378	199	15	40
4308	9000	75	270	6.6	-	227	322	208	15	45
4309	9000	100	270	6.6	-	227	312	199	-	45
4310	10000	N/L	270	1.2	-	-	-	-	-	-
4310	10000	25	270	14.9	-	208	322	199	-	45
4311	10000	50	270	8.5	-	199	341	199	15	45
4312	10000	75	270	5.7	-	194	312	185	-	45
4313	10000	100	270	4.7	-	246	350	194	15	45
4314	11000	N/L	270	1.2	-	-	-	-	-	-
4314	11000	25	270	14.9	-	-	-	-	-	-
4315	11000	50	270	7.6	-	222	331	180	-	50
4316	11000	75	270	7.6	-	246	416	180	-	40
4317	11000	100	270	7.6	-	232	289	204	-	-

TRANSIENT VOLTAGE MUST BE WITHIN LIMITS 350V/200V FOR LOAD APPLICATION AND LOAD REMOVAL. DATA ABOVE SHOWS TWO TRANSIENTS ABOVE 350V AND TEN BELOW 200V.

PLATE NO. 10856

TEST DATA SHEET
4ND-NADC-3960/12 #7

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	9 JUL 80	2 OF 6

MANUFACTURER	MFR'S MODEL NO.
AiResearch (Div of Garrett), Torrance, CA	518988-1-1

TEST	SPEC. NO.	TYPE NO.
Voltage Regulation and Transients	NADC-VT-TS-7502 13 JUN 75	

PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY
			T. Boyce

DESCRIPTION

Voltage regulation rated speeds and with loads of 25, 50, 75 and 100%. Generator was set to desired speed. Momentary loads were applied as follows: 0 to 25%, 0 to 50%, 0 to 75%, and 0 to 100%.

VOLTAGE TRANSIENTS RECOVERY TIME

RECORD NUMBER	SPEED RPM	LOAD %	VOLTS	RIPPLE V P/P	ON LOAD +	ON LOAD -	OFF LOAD +	OFF LOAD -	MILLISEC ON	MILLISEC OFF
4318	11500	N/L	270	1.2	-	-	-	-	-	-
4318	11500	25	270	13.4	-	246	-	203	-	-
4319	11500	50	270	7.6	-	-	322	185	-	45
4320	11500	75	270	-	-	-	-	-	-	-
4321	11500	100	270	6.6	-	251	331	189	-	50
4322	12000	N/L	270	1.2	-	-	-	-	-	-
4322	12000	25	270	12.3	-	218	331	208	15	40
4323	12000	50	270	8.5	-	203	397	199	20	45
4324	12000	75	270	4.7	-	237	326	189	-	40
4325	12000	100	270	-	-	UNREADABLE			-	-
4326	12500	N/L	270	1.2	-	-	-	-	-	-
4326	12500	25	270	12.3	-	246	367	208	-	40
4327	12500	50	270	8.5	-	237	379	189	-	40
4328	12500	75	270	8.5	-	237	377	208	15	45
4329	12500	100	270	7.6	-	237	327	208	15	40

TRANSIENT VOLTAGE (REF. SPEC) MUST BE WITHIN 350V/200V WINDOW FOR LOAD APPLICATION AND REMOVAL. ABOVE DATA SHOWS FOUR TRANSIENTS EXCEEDING 350V AND FIVE BELOW 200V.

PLATE NO. 10856

TEST DATA SHEET
4ND-NADC-3960/12 #7

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	9 JUL 80	3 OF 6
MANUFACTURER		MFR'S MODEL NO.	
AiResearch (Div of Garrett), Torrance, CA		518988-1-1	
TEST Voltage Regulation and Transients	SPEC. NO. 13 JUN 75 NADC-VT-TS-7502	TYPE NO.	
PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY T. Boyce

DESCRIPTION

Voltage regulation at rated speed and with loads of 25%, 50%, 75%, and 100%. Generator was set to desired speed. Momentary loads were as follows: 0 to 25%, 0 to 50%, 0 to 75%, and 0 to 100%.

VOLTAGE TRANSIENTS RECOVERY TIME

RECORD NUMBER	SPEED RPM	LOAD %	VOLTS	RIPPLE V P/P	ON LOAD OFF +	-	+	-	MILLISEC ON	OFF			
4330	13000	N/L	270	1.2	-	-	-	-	-	-			
4330	13000	25	270	12.3	-	218	336	218	-	40			
4331	13000	50	270	8.5	-	238	341	198	15	40			
4332	13000	75	270	6.6	-	241	353	197	15	40			
4333	13000	100	270	6.6	273	246	331	199	15	40			
4334	13500	N/L	270	1.2	-	-	-	-	-	-			
4334	13500	25	270	12.3	-	248	331	213	15	40			
4335	13500	50	270	8.5	-	237	329	194	15	40			
4336	13500	75	270	6.6	275	246	360	197	15	40			
4337	13500	100	270	5.7	276	248	311	199	15	40			

NOTE: RIPPLE VOLTAGE ON ALL TESTS (SHEETS 1, 2, 3 OF 9 JUL) IS WITHIN REFERENCED SPEC LIMIT - 24V P/P. ON SUBSEQUENT TESTS (SHEET 4 FOLLOWING), RIPPLE VOLTAGE INCREASES SIGNIFICANTLY - EXCEEDING SPECIFIED 24V P/P. HOWEVER, GENERATOR DID NOT SHUT DOWN AS REQUIRED. RIPPLE VOLTAGE > 24V P/P FOR 200 MS IS A "SHUT DOWN" FAULT. (SEE TABLE 4-10. FAULT SUMMARY, AIRESEARCH REPORT - NADC-80014-60, 1 MAY 1980.) DATA ABOVE SHOWS TWO TRANSIENTS EXCEEDING 350V AND SIX BELOW 200V.

PLATE NO. 10856

TEST DATA SHEET
4ND-NADC-3960/12 #7

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	9 JUL 80	4 OF 6
MANUFACTURER		MFR'S MODEL NO.	
AiResearch (Div of Garrett), Torrance, CA		518988-1-1	
TEST Voltage Regulation and Transients	SPEC. NO. 13 JUN 75 NADC-VT-TS-7502	TYPE NO.	
PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY T. Boyce

DESCRIPTION

Voltage regulation at rated speed with loads of 25%, 50%, 75%, and 100%. Generator was set to desired speed. Momentary loads were applied as follows: 0 to 25%, 0 to 50%, 0 to 75%, and 0 to 100%.

VOLTAGE TRANSIENTS RECOVERY TIME

RECORD NUMBER	SPEED RPM	LOAD %	VOLTS	RIPPLE V P/P	ON LOAD OFF +	-	+	-	MILLISEC ON	OFF			
4338	14000	N/L	270	1.2	-	-	-	-	-	-			
4338	14000	25	270	57	-	227	374	179	15	40			
4339	14000	50	270	45	284	227	412	175	15	40			
4340	14000	75	270	36	283	232	340	199	15	40			
4341	14000	100	270	27	-	232	358	197	15	40			
4342	14500	N/L	270	9.5	-	-	-	-	-	-			
4342	14500	25	270	57	283	220	365	168	-	-			
4343	14500	50	270	43	279	227	407	192	15	40			
4344	14500	75	270	33	279	232	416	170	15	40			
4345	14500	100	270	26	-	232	355	189	15	40			
4346	15000	N/L	270	9.5	-	-	-	-	-	-			
4346	15000	25	270	53	-	222	379	175	15	40			
4347	15000	50	270	41	293	229	341	189	15	40			
4348	15000	75	270	29	-	227	388	161	15	40			
4349	15000	100	270	26	281	236	335	161	15	40			

RIPPLE VOLTAGE EXCEEDS REQUIREMENTS - 24V P/P (REF. SPEC). TRANSIENT VOLTAGE (REF. SPEC) MUST BE WITHIN 350V/200V WINDOW FOR LOAD APPLICATION AND REMOVAL. ABOVE DATA SHOWS ELEVEN TRANSIENTS IN EXCESS OF 350V AND TWELVE BELOW 200V.

PLATE NO. 10856

TEST DATA SHEET
4ND-NADC-3960/12 #7

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	9 JUL 80	5 OF 6

MANUFACTURER	MFR'S MODEL NO.
AiResearch (Div of Garrett), Torrance, CA	518988-1-1

TEST	SPEC. NO.	TYPE NO.
Voltage Regulation and Transients	13 JUN 75 NADC-VT-TS-7502	

PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY
			T. Boyce

DESCRIPTION

Voltage regulation at rated speed with loads of 25%, 50%, 75%, and 100%. Generator was set to desired speed. Momentary loads were applied as follows: 0 to 25%, 0 to 50%, 0 to 75%, and 0 to 100%.

VOLTAGE TRANSIENTS RECOVERY TIME

RECORD NUMBER	SPEED RPM	LOAD %	VOLTS	RIPPLE V P/P	ON LOAD OFF +	-	+	-	MILLISEC ON	OFF
4350	15500	N/L	270	9.5	-	-	-	-	-	-
4350	15500	25	270	52	288	253	379	165	15	40
4351	15500	50	270	38	283	227	378	170	15	40
4352	15500	75	270	31	293	228	338	160	15	40
4353	15500	100	270	24	291	229	350	165	15	40
4354	16000	N/L	270	12	-	-	-	-	-	-
4354	16000	25	270	43	298	227	378	156	-	40
4355	16000	50	270	38	293	212	421	165	-	45
4356	16000	75	270	24	283	227	378	151	-	45
4357	16000	100	270	24	293	237	357	160	15	40
4358	16500	N/L	270	11.4	-	-	-	-	-	-
4358	16500	25	270	47	300	225	364	172	15	40
4359	16500	50	270	37	295	229	395	156	-	40
4360	16500	75	270	30	291	220	350	182	15	40
4361	16500	100	270	23	285	229	345	160	15	40

RIPPLE VOLTAGE EXCEEDS REQUIREMENTS - 24V P/P (REF. SPEC). TRANSIENT VOLTAGE (REF. SPEC) MUST BE WITHIN 350V/200V WINDOW FOR LOAD APPLICATION AND REMOVAL. ABOVE DATA SHOWS NINE TRANSIENTS IN EXCESS OF 350V AND TWELVE BELOW 200V.

PLATE NO. 10856

TEST DATA SHEET
4MD-NADC-3960/12 #7

ITEM	COMPONENT OF	DATE	PAGE
270V DC Generator	AAES	9 JUL 80	6 OF 6
MANUFACTURER		MFR'S MODEL NO.	
AiResearch (Div of Garrett), Torrance, CA		518988-1-1	
TEST Voltage Regulation and Transients	SPEC. NO. 13 JUN 75 NADC-VT-TS-7502	TYPE NO.	
PRIORITY NO.	TED EL NO.	QUANTITY	TEST BY T. Boyce

DESCRIPTION

Voltage regulation at rated speed with loads of 25%, 50%, 75%, and 100%. Generator was set to desired speed. Momentary loads were applied as follows: 0 to 25%, 0 to 50%, 0 to 75%, and 0 to 100%.

VOLTAGE TRANSIENTS RECOVERY TIME

RECORD NUMBER	SPEED RPM	LOAD %	VOLTS	RIPPLE V P/P	ON LOAD OFF +	-	+	-	MILLISEC ON	OFF
4362	17000	N/L	270	9.5	-	-	-	-	-	-
4362	17000	25	270	3.7	-	-	398	159	-	40
4363	17000	50	270	37	304	217	380	172	15	40
4364	17000	75	270	28	291	236	463	149	15	40
4365	17000	100	270	22	283	227	335	158	15	40
4366	17500	N/L	270	9.5	-	-	-	-	-	-
4366	17500	25	270	43.2	VOLTAGE DROPS OUT AFTER 440 MSEC					
4367	17500	50	NO VOLTAGE							
4368	17500	75	NO VOLTAGE							
4369	17500	100	NO VOLTAGE							
	GENERATOR DRIVE REDUCED TO 9000 RPM - NO VOLTAGE									
	GENERATOR TO OFF THEN TO TEST, VOLTAGE 270V									
4370	18000	25	270	42	-	-	395	169	-	40
4371	18000	50	270	38	313	219	420	170	15	45
*4372	18000	75	270	24/31	293	231	437	162	15	40
4373	18000	100	270	24	291	250	357	165	15	40

*RIPPLE STARTED AT 24V P/P, INCREASED TO 31V P/P 250 MSEC AFTER LOAD WAS APPLIED.

PLATE NO. 10856

CONCLUSIONS

1. The generator control unit failed to shut down the generator under high ripple voltage. There is a malfunction in the "Fault" circuitry.

2. Coolanol 25 flash point changed after use in the generator cooling system; it became flammable at room temperature. Therefore, it is not suitable for aircraft generator coolant application.

RECOMMENDATIONS

1. Investigate high ripple fault circuitry to determine cause of malfunction.

2. Use Aircraft Turbo Shaft Engine Lube Oil (MIL-L-23699) as coolant in subsequent AiResearch 270 volt DC generators.

3. Return the failed generator to AiResearch for failure analysis, repair, and refurbish if practical.